



**ELECTRO-MOTIVE**  
**SD70M-2**  
**LOCOMOTIVE**  
**CANADIAN NATIONAL**  
**RAILWAYS**  
**OPERATOR'S**  
**MANUAL**

First Edition, November 2005

**An Electro-Motive Diesel, Inc. Publication**

Electro-Motive Diesel, Inc.  
La Grange, Illinois 60525 USA  
Telephone: 708-387-6000





**ELECTRO-MOTIVE**  
**SD70M-2**  
**LOCOMOTIVE**  
**CANADIAN NATIONAL**  
**RAILWAYS**  
**OPERATOR'S**  
**MANUAL**

First Edition, November 2005

**An Electro-Motive Diesel, Inc. Publication**

Electro-Motive Diesel, Inc.  
La Grange, Illinois 60525 USA  
Telephone: 708-387-6000

To order this publication in printed form, please use part number O00440EP.

To order this publication on a CD, please use part number O00440ED.

©Copyright 2005

Electro-Motive Diesel, Inc. All rights reserved. Neither this document, nor any part thereof, may be reprinted without the expressed written consent of Electro-Motive. Contact EMD Customer Publications Office.

---

---

# Section 1 General Information

---

---

## Contents of Section

<u>Heading</u>	<u>Page</u>
LOCOMOTIVE GENERAL DATA .....	1-3
LOCOMOTIVE GENERAL DESCRIPTION .....	1-6
LOCOMOTIVE OPERATION .....	1-11
INTRODUCTION TO FIRE GEN II SYSTEM .....	1-14
INTRODUCTION TO EMD DIESEL ENGINE CONTROL (EMDEC) SYSTEM .....	1-17
INTRODUCTION TO ELECTRONIC AIR BRAKE SYSTEM .....	1-18

---

---

# Short Table of Contents

---

---

The following sections make up this manual. A complete section contents listing appears on the first page of each section.

<b><u>Heading</u></b>	<b><u>Page</u></b>
<b>Forward .....</b>	<b>For-i</b>
<b>Section 1. General Information .....</b>	<b>1-1</b>
<b>Section 2. Controls and Indicators .....</b>	<b>2-1</b>
<b>Section 3. Operation .....</b>	<b>3-1</b>
<b>Section 4. Troubleshooting .....</b>	<b>4-1</b>
<b>Index .....</b>	<b>Ind-i</b>



---

---

# Forward

---

---

## Contents of Section

<u>Heading</u>	<u>Page</u>
INTRODUCTION TO MANUAL .....	For-iii
Crew Member Terms Used in this Manual .....	For-iii

# INTRODUCTION TO MANUAL

This manual is intended for railroad personnel who operate Electro-Motive Diesel, Inc. SD70M-2 Tier 2 locomotives equipped to meet Tier 2 emission standards. In this book these locomotives are called **SD70M-2**.

The SD70M-2 is equipped with a microprocessor-based control system. In this manual, the microprocessor is called either "locomotive computer" and/or "EM2000."

EM2000 monitors and controls locomotive traction power and dynamic braking, records and indicates faults, and enables testing various locomotive systems.

EM2000 also *displays* information in the locomotive cab, on the engineer's control console, through FIRE system display panels, which include keypads. The FIRE system is an important locomotive crew/locomotive control system interface.

The manual includes information compiled for typical SD70M-2's with basic equipment and certain extras. For special extra equipment, consult specific drawings or instructions as provided by the railroad.

These instructions do not cover all details or variations in equipment, nor provide for every possible contingency. If further information is required, or if problems arise which are not covered sufficiently, contact an Electro-Motive representative.

Information about adjusting, testing, and maintaining the locomotive and its equipment is provided in other Electro-Motive publications such as the SD70M-2 Locomotive Running Maintenance Manual, and various Maintenance Instructions.

This balance of this manual is divided into four sections:

### **Section 1. General Information**

General SD70M-2 data and descriptions.

### **Section 2. Controls and Indicating Devices**

Describes devices used by SD70M-2 crew.

### **Section 3. Operation**

Presents SD70M-2 locomotive operating procedures and guidelines.

### **Section 4. Troubleshooting**

How to use SD70M-2 locomotive computer (EM2000) and FIRE Gen. II display systems. Typical display system messages.

For greatest benefit, read the sections above in numerical order.

## **Crew Member Terms Used in this Manual**

In this manual, the crew member who is principally responsible for locomotive operation is called the **engineer**, and his assistant is called the **helper**.

Railroads may use various other names in place of engineer, such as operator or driver, and they may call his helper the assistant, the conductor, the brakeman, the fireman, the observer, the inspector - or various combinations of those terms.





---

---

# Section 1 General Information

---

---

## Contents of Section

<u>Heading</u>	<u>Page</u>
LOCOMOTIVE GENERAL DATA .....	1-3
LOCOMOTIVE GENERAL DESCRIPTION .....	1-6
LOCOMOTIVE OPERATION .....	1-11
INTRODUCTION TO FIRE GEN II SYSTEM .....	1-14
INTRODUCTION TO EMD DIESEL ENGINE CONTROL (EMDEC) SYSTEM.....	1-17
INTRODUCTION TO ELECTRONIC AIR BRAKE SYSTEM .....	1-18



# LOCOMOTIVE GENERAL DATA

## **Locomotive Model Designation .....SD70M-2**

Locomotive Type ..... (C-C) 0660

Locomotive Power (Nominal)..... 4300 HP

### **Power Plant**

Engine Type..... Turbocharged Two-stroke Diesel

Model..... 16-710G3C-T2

Number of Cylinders ..... 16

Fuel Injection Type .....Electronic Unit Injection

Nominal Full Speed ..... 950 RPM

Idle Speed, Normal ..... 269 RPM

Idle Speed, Low ..... 200 RPM

### **Main Generator Assembly:**

#### **Model AR20-CA9**

##### **AR20 Traction Alternator Rectified Output**

Maximum Potential .....1465 VDC

Max. Continuous Current.....8100 A

##### **CA9 Companion Alternator Output**

Nominal Potential.....200 and 400 VAC

### **APC Auxiliary Power Converter**

Rectified Potential.....74 VDC

Maximum Power Output .....31 kW

### **Traction Motors:**

#### **Model D100**

Quantity .....6 (3 per Truck)

Type.....DC, Series-Wound, Axle-Hung, Tapered Roller  
Support Bearings, Forced Air Ventilated

## Locomotive Batteries

Arrangement..... 2-32 Volt 325 ampere hour  
Total Quantity of Cells ..... 32  
Total Potential of Series Connected Batteries.... 64 VDC

## Air Brake System

Model..... Wabtec FastBrake EAB  
Type ..... Electro-Pneumatic, Micro-Controlled,  
w/FIRE Interface

## Air Compressor

Model..... WLN  
Type ..... 3-Cyl., 2-Stage, Water-Cooled,  
Hot Water-Heated Sump  
Drive..... Engine Driven  
Displacement @ 950RPM  
Compressor Speed..... 268 CFM  
Lube Oil Capacity (20 Wt.) ..... 17.5 U.S. Gal.  
Set Points:  
Load ..... 130 PSIG  
Unload..... 140 PSIG

## Locomotive Speed Limitation

**Note:** Limits are based on original equipment,  
consisting of:

- 83:18 gear ratio
- 43" diameter wheels.

Rated Maximum ..... 70 MPH  
Locomotive Overspeed ..... 73 MPH  
Minimum Continuous . 12.2 MPH @ 112,000 Lbs.T.E.  
Peak Dynamic Brake Effort.. 89 000 lbs @ 21.9 MPH

**Note:** To protect traction motors, EM2000 may reduce  
tractive effort to "Minimum Continuous" level during  
extended motoring episodes that are slower than  
approximately 11.4 MPH.

## **Supplies/ Capacities**

Lube Oil System Capacity .....	420 U.S. Gal.
Cooling System Capacity .....	325 U.S. Gal.
Sanding System Capacity .....	40 Cu. Ft. (20 Cu. Ft./ End)
Fuel Tank.....	4900 U.S. Gal.
Retention Tank .....	100 U.S. Gal.

## **Nominal Dimensions**

Length over coupler pulling faces .....	74Ft. 3.00 In.
Width over long hood handrails .....	10Ft. 8.00 In.
Maximum Height.....	15Ft. 11 In.

## **Locomotive Weight**

Nominal, including all supplies.....	412,000 Lbs.
Weight on Drivers .....	100%

## **Minimum Curve Negotiation**

Following data is based on a SD70M-2 with E type couplers.

Single SD70M-2:..... 231 Ft. Radius/25° Curve

Two SD70M-2's  
(with E Couplers): ..... 260 Ft. Radius/22.2° Curve

# LOCOMOTIVE GENERAL DESCRIPTION

The Electro-Motive Diesel, Inc. Model SD70M-2 T-2 diesel-electric locomotive is equipped with a turbocharged 16 cylinder diesel engine, which drives the main generator assembly. (T-2 signifies that the locomotive meets Tier 2 emission regulations) The main generator assembly consists of the traction alternator, the companion alternator, the traction alternator rectifier banks, the common traction alternator/ companion alternator shaft, and the common housing. The rectifier banks rectify AC electrical power from the traction alternator and electrical control cabinet devices distribute the rectified DC power to the traction motors. Each of the six traction motors has a pinion gear that meshes with the bull gear on its wheelset. (A wheelset consists of an axle fitted with two wheels and a bullgear.)

The CA9 companion alternator produces three-phase AC power. CA9 power drives auxiliary AC equipment, such as engine radiator cooling fans and various blowers. CA9 also provides excitation field current for the AR20. Note that on the SD70M-2 locomotive, battery charging and other low power (74VDC) systems are supplied by the companion alternator through the **Auxiliary Power Converter (APC)**.

The SD70M-2 T2 locomotive is arranged and equipped so that the short hood or cab end is considered the front or forward end. However, the locomotive operates equally well in either direction.

Each SD70M-2 T2 locomotive is an independent power source; several may be combined in a multiple-unit consist to increase load capacity. For MU (multiple-unit) operation, the operating controls on each locomotive are jumpered or "trainlined" to the adjacent locomotives, enabling all locomotives in consist to be simultaneously controlled from the lead unit.

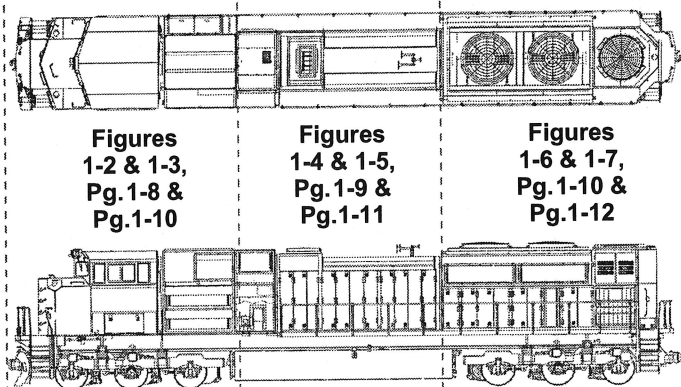
The SD70M-2 locomotive is equipped with a microprocessor-based control system. The microprocessor is called the "locomotive computer" or the "EM2000."

**EM2000 monitors and controls locomotive traction power and dynamic braking, records and indicates faults, and enables diagnostic testing of certain locomotive systems.**

The FIRE display panel in the engineer's lower console locomotive operating conditions, system faults, and troubleshooting information.

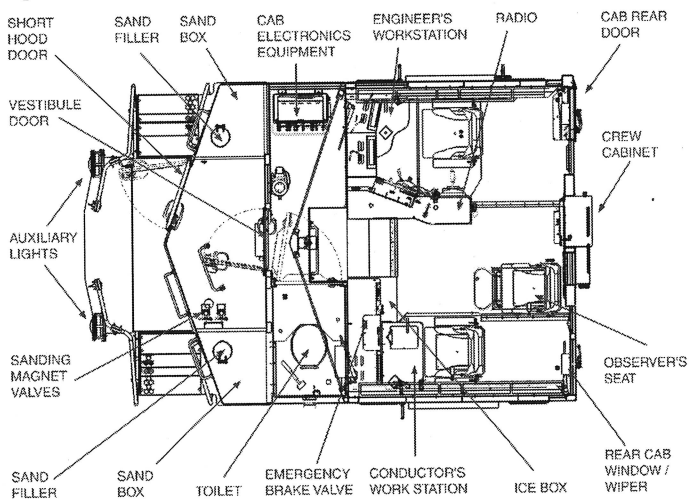
**Note:** On this locomotive, the engine start switch is in the cab, on the engine control panel.





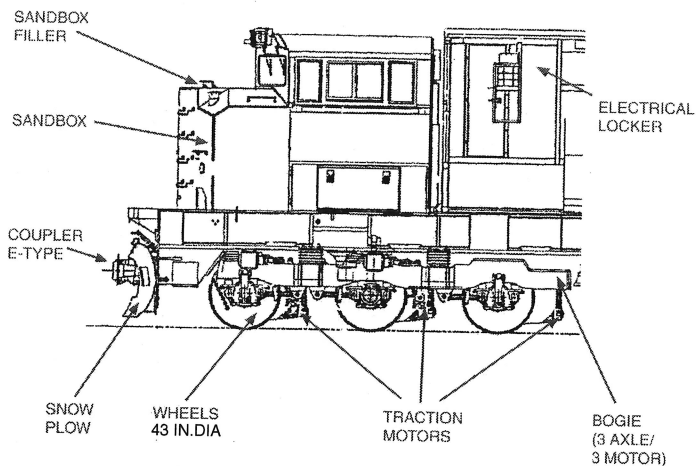
F51060

**Figure 1-1. Key to General Arrangement Illustrations**



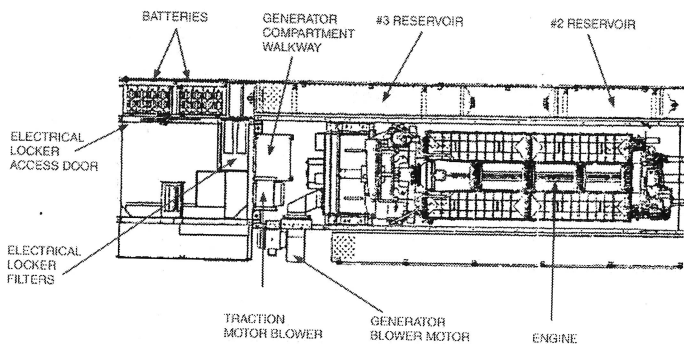
F51059

**Figure 1-2. General Arrangement, Front Top View**



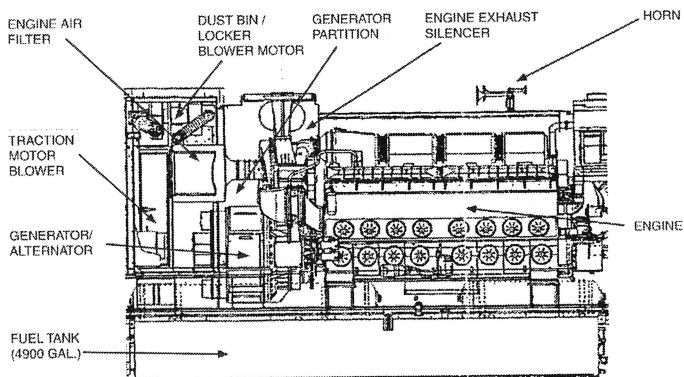
F51058

**Figure 1-3. General Arrangement, Front Left Side View**



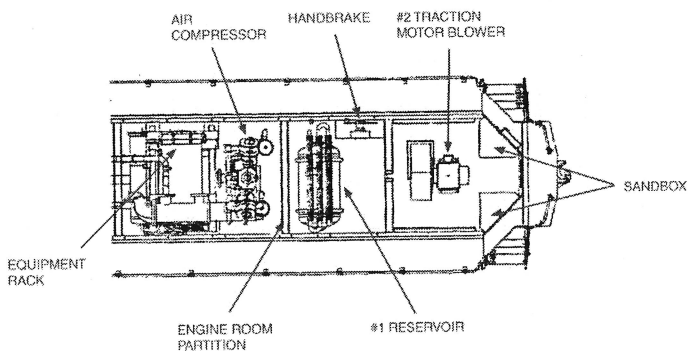
F51057

**Figure 1-4. General Arrangement, Middle Top View**



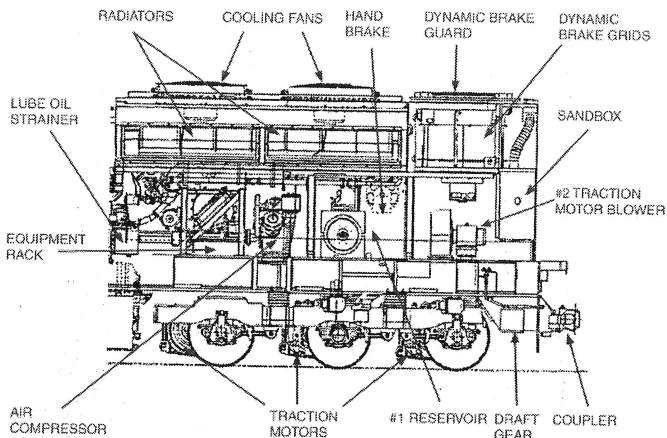
F51056

**Figure 1-5. General Arrangement, Middle Left Side View**



F51055

**Figure 1-6. General Arrangement, Rear Top View**



F51054

**Figure 1-7. General Arrangement - Rear Left Side View**

## **LOCOMOTIVE OPERATION**

Pressing the engine control panel START pushbutton causes locomotive computer EM2000 to initiate the engine start sequence:

1. Turbo Lube Pump Initiates
2. Fuel Prime Cycle
3. Audible Warning
4. Starter Motor Cranks Engine
5. Engine Starts

The fuel pump motor operates on locomotive battery power before the engine is running. It pumps fuel from the tank under the locomotive to the injectors, pressurizing the fuel injection system.

When the system has been primed, and the Electro-Motive diesel engine control system (EMDEC) has set the injection pumps, the air starter motor engages to crank the engine, and the engine starts.

When the diesel engine is running, it directly drives two electrical generators, an air compressor and the water and lube oil pumps.

The two electrical generators are:

- Companion Alternator
- Traction Alternator

The companion alternator is physically coupled to the traction alternator. Both alternators are directly driven by the engine and turns at engine speed. As soon as 74VDC is applied to the companion alternator field, the companion alternator starts producing AC power. The power produced by the companion alternator is used to:

- Excite Main Generator Field Supply Chopper
- Excite APC (Auxiliary Power Converter)
- Power the Inertial Filter Blower Motor
- Power the Radiator Cooling Fans
- Power the Traction Motor Blowers
- Power the Generator Blower Motor

The auxiliary power converter 74 VDC output is used to excite the companion alternator and provide power for battery charging, air conditioning/heating, fuel pump, turbo lube pump and various control circuits.

The traction alternator provides the traction motors with power. Excitation current is applied to the alternator producing AC power which is rectified to DC by rectifier assemblies and applied to six DC traction motors for traction effort.

While controlling the main generator output, the EM2000 locomotive computer takes into consideration such data as operator control settings (throttle notch, etc.), locomotive operating conditions, and feedback information (ambient conditions and locomotive performance).

EM2000 displays control system information on the FIRE display panel in the cab.

If a fault occurs, the EMDEC load regulator function requests the EM2000 to reduce traction alternator excitation, which can prevent engine overloading.

EMDEC holds engine speed constant for each throttle position by controlling the engine fuel injection rate.

Advancing the throttle handle requests the EMDEC computer to raise engine speed. At the same time EM2000 increases traction alternator field current, which, in turn increases the main generator output to provide more power to the traction motor circuits.

In dynamic brake operation, the energy of the moving train rotates the traction motors, and the traction motors generate power instead of using it. This reversal of power direction reverses traction torque reaction, causing the traction motors to brake instead of pulling.

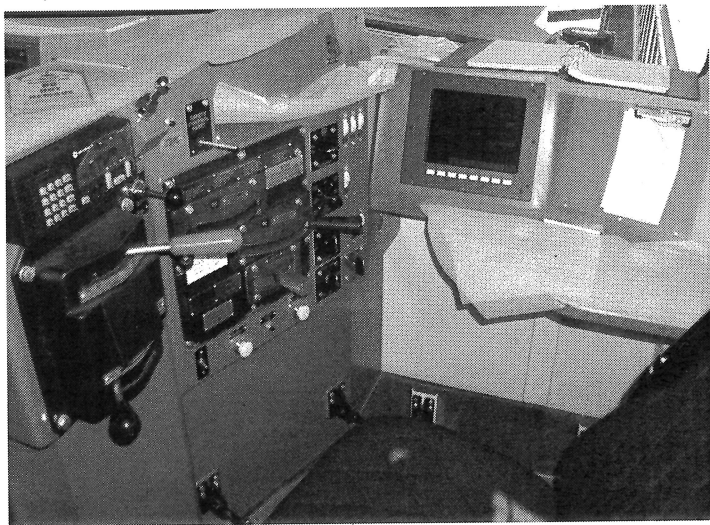
In dynamic braking, the dynamic brake grid circuits are connected across the traction motor circuits and brake grids are used to dissipate the electrical power generated by the traction motors as heat. The computer monitors and controls the traction motor power output, controlling dynamic braking as required. EM2000 controls dynamic braking effort in response to the dynamic brake handle setting and locomotive speed.

Other control and protective functions are programmed into the EM2000 - it monitors critical functions in the locomotive power system and, if a fault occurs, provides a FIRE display message - in some cases triggering an audible alarm.

The EM2000 also requests EMDEC to change diesel engine speed and power in response to certain improper operating conditions such as low coolant temperature or low main reservoir pressure. EM2000 restores engine speed and power when these conditions are corrected.

An important locomotive control aspect is the relationship of throttle setting, engine speed control, and load regulation. Locomotive computer EM2000 controls throttle setting in response to throttle handle setting and other locomotive conditions. The EMDEC system (Electro-Motive diesel engine control) controls engine speed in response to the throttle setting requested by EM2000 and various engine conditions, and it supplies engine loading information to EM2000.

## **INTRODUCTION TO FIRE GEN II SYSTEM**



F80002

**Figure 1-8. Engineer's Workstation, Typical**

FIRE stands for **F**unctionally **I**ntegrated **R**ailroad **E**lectronics. Figure 1-8 illustrates the FIRE display panel on the engineer's workstation.

Because this locomotive incorporates the FIRE system, many console operator devices and indicators present on other locomotive models are not required on this locomotive they are replaced by the FIRE system.

FIRE display panels are interactive, enabling the locomotive crew to:

- Request information from locomotive computer EM2000, and view it.
- Perform certain EM2000 functions, such as fault reset.
- Set up and/or operate cab electronics subsystems.

Since the FIRE system displays all necessary EM2000 information, there is no EM2000 display panel on the electrical control cabinet or on the overhead console.

In addition, the FIRE system serves as the communications hub for the cab electronics system, the network of interconnected locomotive subsystems listed in the table appearing on the next two pages.

The table also describes how the various subsystems relate to the FIRE system itself. For more FIRE system information, see description of engineer's FIRE panel, starting on page 2-10.

<b>Locomotive Electronics Subsystem</b>	<b>Relationship to FIRE System</b>
Alerter	FIRE includes alerter system control. ALERT indicator, with countdown, displays on FIRE screen.
Distance/ Length Counter	FIRE performs counting function and provides crew interface.



<b>Locomotive Electronics Subsystem</b>	<b>Relationship to FIRE System</b>
Electronic Air Brake	FIRE provides a setup interface.
EM2000 Locomotive Computer	FIRE is crew interface.
Event Recorder	Per railroad/ FRA rules, FIRE collects, records, and can download locomotive and operator data and events.
Fuel Tank Monitor	FIRE receives fuel depth information, converts it, and displays fuel quantity.
Head-of-Train (HOT)/ End-of-Train(EOT)	FIRE displays EOT device status that HOT device receives. FIRE also relays end of train emergency brake requests to HOT device.
Speed Indicator System	FIRE displays Speed from traction motor sources and relays it to other systems.

# **INTRODUCTION TO EMD DIESEL ENGINE CONTROL (EMDEC) SYSTEM**

On this locomotive, EMDEC electronically sets and adjusts engine fuel injection to produce the horsepower and engine speed scheduled for the throttle setting set by the EM2000 locomotive computer. Therefore, the engine governor, the injector racks, the layshaft and mechanical overspeed mechanism are not present on this locomotive.

The engine low water pressure and crankcase over pressure mechanisms have also been replaced by electronic pressure sensors connected to EMDEC.

## **Details:**

- EMDEC uses the EM2000 throttle setting to determine the basic engine fuel injection rate.
- As changing operating conditions create changes in traction alternator loading or engine output power, engine speed may momentarily change. EMDEC corrects engine speed by adjusting the fuel injection rate.
- EMDEC system sends an engine loading status signal to EM2000. The status signal is based on actual engine fuel injection rate vs. scheduled engine fuel injection rate.
- EM2000 adjusts load on the engine by varying traction alternator field excitation, based on engine loading status signal.

# **INTRODUCTION TO ELECTRONIC AIR BRAKE SYSTEM**

This locomotive is equipped with a computer-controlled air brake system that is set up by the FIRE system. The air brake system controls air brakes on locomotives and cars coupled in trains. The FIRE system provides an interface with the air brake system to configure set-up options and perform various tests.

Using a computer to control the air brake system eliminates many electrical and pneumatic air brake system devices, reducing maintenance and simplifying troubleshooting.

Conventional air brake system pneumatic control relays and valves are replaced in this system by the electro-pneumatic control unit in the cab sub-base.

The air brake system computer controls the electro-pneumatic control unit - it operates various portions of the electro-pneumatic control unit to produce the required automatic and independent brake functions.

The air brake controller mounts on the engineer's workstation. It includes the automatic and independent brake handles and electrical devices operated by the handles. The handle-operated electrical devices send signals to the air brake computer.

---

---

# Section 2

## Controls and Indicators

---

---

### Contents of Section

<u>Heading</u>	<u>Page</u>
<b>CAB EQUIPMENT .....</b>	<b>2-3</b>
<b>UPPER (OVERHEAD) CONTROLS .....</b>	<b>2-3</b>
<b>ENGINEER'S WORKSTATION.....</b>	<b>2-5</b>
SWITCH PANEL .....	2-6
FRONT INSTRUMENT PANEL, ENGINEER'S WORKSTATION .....	2-10
AIR BRAKE EQUIPMENT .....	2-31
MISCELLANEOUS CONTROLS .....	2-40
<b>CONDUCTOR'S WORKSTATION .....</b>	<b>2-43</b>
<b>ENGINE CONTROL PANEL .....</b>	<b>2-44</b>
SLIDE SWITCHES .....	2-48
CIRCUIT BREAKER PANEL .....	2-50
<b>SHORT HOOD INNER VESTIBULE .....</b>	<b>2-54</b>
CAB ELECTRONICS COMPARTMENT .....	2-54
TOILET COMPARTMENT .....	2-54
<b>ENGINE ROOM EQUIPMENT .....</b>	<b>2-55</b>
ENGINE START ALARM HORN .....	2-55
WATER TEMPERATURE .....	2-55
LUBE OIL TEMPERATURE AND PRESSURE.....	2-55
FUEL FILTER PRESSURE .....	2-56
AIR PRESSURE TRANSDUCER .....	2-56
ENGINE OVERSPEED CONTROL .....	2-56
MANUAL SHUTTER CONTROL VALVE .....	2-56
<b>MISCELLANEOUS EQUIPMENT .....</b>	<b>2-57</b>
EFCO SWITCHES, EXTERNAL .....	2-57
REMOTE FUEL GAUGES .....	2-57
HANDBRAKE .....	2-57
FIRE EXTINGUISHERS .....	2-57
CAB SEATS .....	2-58



# CAB EQUIPMENT

These are the cab areas that include most of the locomotive operator control equipment:

- **Upper (overhead) controls** - description begins below.
- The **engineer's workstation**- description starts on page 2-5.
- The **conductor's workstation** - description starts on page 2-43.
- The **electrical control cabinet** - description starts on page 2-44.

## UPPER (OVERHEAD) CONTROLS

Some equipment used by the locomotive crew is mounted on overhead panels, or attached to the cab front bulkhead. Located above the seats on the conductor's side and the engineer's side, Figure 2-1 and Figure 2-2, are controls for the window wipers, reading lights, and ventilation.



F51083

**Figure 2-1. Upper Controls (Conductor's Side)**



F51085

**Figure 2-2. Upper Controls (Engineer's Side)**

The following paragraphs describe these overhead devices.

#### **Reading Light, with Switch**

The overhead reading lights project from the underside of the ceiling. A rocker switch located on the lower right corner of the light assembly provides On/Off control.

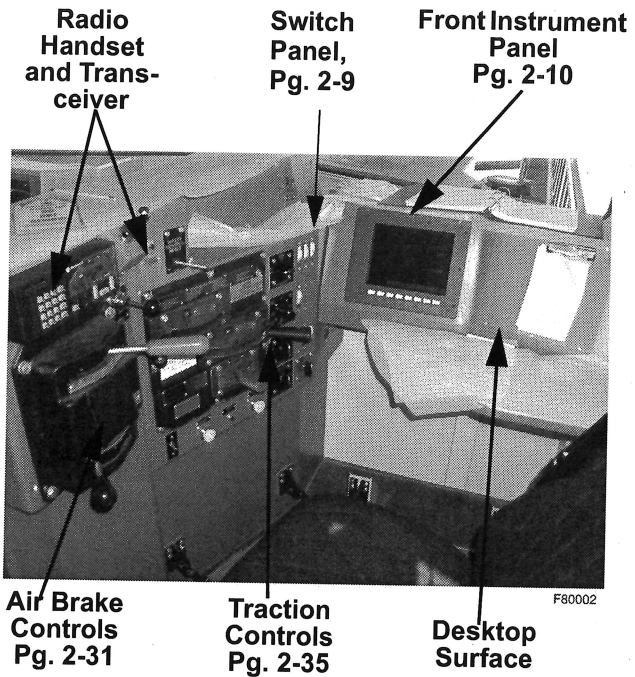
#### **Window Wiper Controls**

The wiper controls are mounted in overhead panels on both sides of the locomotive. There is a control knob for the front wipers, and a second knob for the rear wipers on each side. Turning the knob (valve) counter-clockwise activates the wipers. Speed is controlled by modulating the valve.

#### **Overhead Ventilation Controls**

The overhead ventilation controls are mounted on overhead both sides of the locomotive above the windows, as shown in Figure 2-1 and Figure 2-2. The volume and direction of air flow can be controlled by operating the louvers on the vents.

# ENGINEER'S WORKSTATION



**Figure 2-3. Engineer's Workstation**

The engineer's workstation, houses the frequently used engineer equipment.



## SWITCH PANEL

The switch panel, mounts on the center section of the engineer's workstation and includes the following devices:



F80027

**Figure 2-4. Switch Panel**

### HDLTS-FRONT Rotary Switch

This switch controls locomotive front (short hood end) headlights. The settings of this switch are:

- OFF: Headlights are shut Off.
- DIM: Headlights On dimly.
- BRT/DITCH LTS: Headlights On at maximum intensity.  
Auxiliary headlights (Ditch) will also be on in this position.

**Note:** Electrical control cabinet HDLTS/AUX LTS breaker, page 2-52, must be On to operate the headlights. Engine control panel HEADLIGHT CONTROL switch, page 2-45, also affects headlight operation.

## HEATER-A/C Rotary Switch

This switch controls the heating and cooling operation of the cab ventilation system. The operation of the switch is as follows:

- OFF: Heating and cooling are shut Off.
- LOW FAN: Fan operation only in low speed.
- HIGH FAN: Fan operation only in high speed.
- LOW HEAT: Fan operation plus low heat.
- MED HEAT: Fan operation plus medium heat.
- HIGH HEAT: Fan operation plus high heat.
- LOW COOL: Fan operation plus low cooling.
- HIGH COOL: Fan operation plus high cooling.

## HDLTS-REAR Rotary Switch

This switch controls locomotive rear (long hood end) headlights. Its settings are:

- OFF: Rear headlights are shut Off.
- DIM: Rear headlights On dimly.
- BRT/DITCH LTS: Headlights On at maximum intensity.  
Auxiliary headlights (Ditch) will also be on in this position.

## DITCH LIGHTS DIRECTIONAL Rotary Switch

This two position switch controls locomotive short hood and long hood ditch light operation. This switch allows the engineer to control the short hood or long hood light operation depending on direction of travel.

**Note:** Steady on ditch lights require headlight control switch in bright position.

## DITCH LIGHT Switch

This switch controls operation (on/off) of the long hood or short hood lights depending on the position of the ditch light directional switch.

## **CONTROL & OPERATING SWITCHES**

The control and operating switches, ENGINE RUN, FUEL PUMP, AND GEN. FIELD are slide switches on the switch panel upper right, as shown in Figure 2-4, page 2-6. To switch a slide switch On (closing its contacts), slide the slider upward; to switch it Off (opening its contacts), slide its slider down. Detailed switch descriptions follow.

### **ENGINE RUN Switch**

This switch must be On, slider Up, when the locomotive leads in a consist, and must be Off, slider Down, when locomotive trails or is dead in a consist.

When the ENGINE RUN switch is On, the locomotive control system controls diesel engine speed according to throttle handle setting. When the ENGINE RUN switch is Off, engine speed is not affected by throttle handle setting.

### **FUEL PUMP Switch**

This switch must be On, slider Up, when the locomotive leads in consist, and must be Off when the locomotive trails or is dead in consist.

When the FUEL PUMP switch is On, it enables various trainlined control circuits. The switch must be On to enable diesel engine fuel priming and starting.

### **GEN. FIELD Switch**

This switch must be On, slider Up, when the locomotive leads in consist, and must be Off when the locomotive trails or is dead in consist.

There are several switches located on the center right, and lower right portion of the switch panel that are used to control various devices such as lighting circuits. The switches located in this area are:

### **No. BD LIGHTS Switch**

This slide switch controls the locomotive number board lights on the front of the locomotive. The lights are On when the switch slider is Up, provided the electrical control cabinet LIGHTS breaker, page 2-52, is also On (lever Up).

### **GAUGE LIGHTS Switch**

This slide switch controls the gauge lights located on the engineers workstation. The lights are On when the switch slider is Up, provided the electrical control cabinet LIGHTS breaker, page 2-52, is also On (lever Up). Note that these lights are equipped with a dimmer switch located on the side of the workstation.

### **PLT/STP LIGHTS Switch**

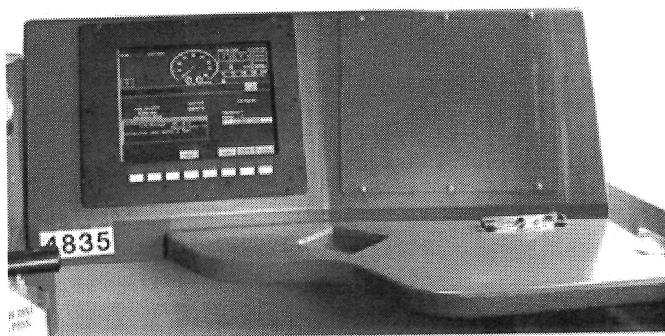
This slide switch controls the locomotive platform and step lights. The lights are On when the switch slider is Up, provided the electrical control cabinet LIGHTS breaker, page 2-52, is also On (lever Up).

### **GROUND LIGHTS Switch**

This slide switch controls the locomotive ground lights. The lights are On when the switch slider is Up, provided the electrical control cabinet LIGHTS breaker, page 2-52, is also On (lever Up).

## FRONT INSTRUMENT PANEL, ENGINEER'S WORKSTATION

The front instrument panel is a near-vertical panel that faces the engineer as he sits at the workstation, as shown on Figure 2-5. The FIRE display panels and the engineer's work desk are located here.



**Figure 2-5. Front Instrument Panel**

### FIRE Display Panel

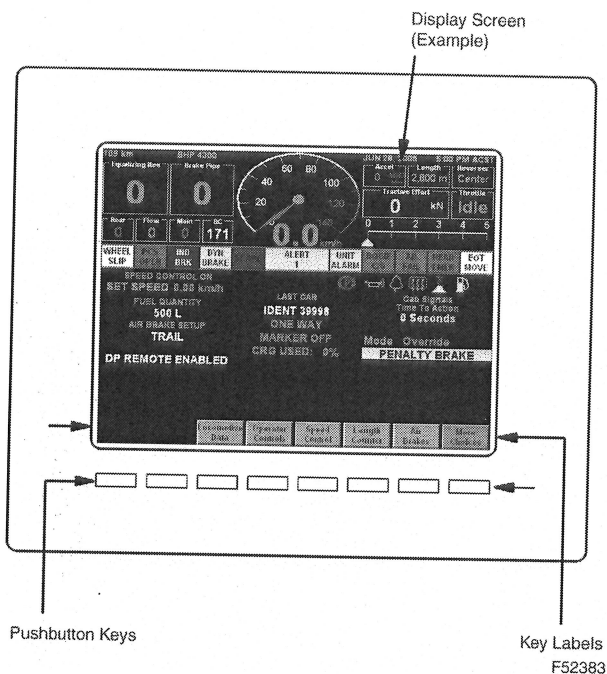
The FIRE display panel integrates many control and indicating functions into one system. Figure 2-6, page 2-11, illustrates a typical FIRE display panel. By using the FIRE display panel, the engineer can view important operating data and respond to various locomotive sub-systems (including locomotive computer EM2000) directly from the workstation.

The FIRE panel is equipped with a display and eight pushbutton keys that enables the engineer to select or activate menu items listed on-screen key labels.

**In this manual, "press the xxxx key," means press the key directly below the xxxx key label on the FIRE panel.** See Figure 2-6.

As described on the next few pages, the engineer can choose to display various types of data on the FIRE panel. Follow applicable railroad regulations when making such decisions.

Procedures in this section of the manual describes how to use the FIRE display panel for various functions.



**Figure 2-6. FIRE Display Panel**

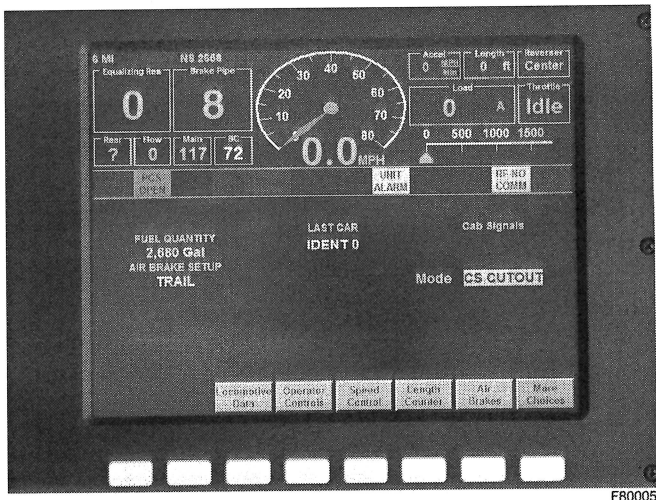
### Engineer's FIRE Display Panel

The engineer's FIRE panel displays locomotive operational data that was indicated on various discrete devices (meters, gauges, indicator lights, etc.) on previous model locomotives.

This panel also enables the engineer to set up and/or display and/or operate, as required, any of the following functions when the appropriate menu choice is keyed.

- Air Brake Set-Up/Testing
- Alarm Bell Silence
- Climate Control (Windshield Defogger)
- Display Mode
- Length Counter

- Departure Tests (part of Maint. Mode):
  - Penalty Brake
  - Alerter
  - Overspeed
- Air Brake Set Up:
  - Sets Up Locomotive for lead or trail Operation
  - Cut-in or cut-out brakes for lead or trail operation.



**Figure 2-7. FIRE Display Panel**

The following paragraphs describe details of the Figure 2-8 screen.

#### Upper Left Corner of Figure 2-8 screen

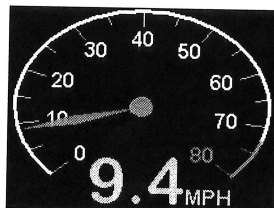
This area, typically illustrated by Figure 2-8, includes:

- **Locomotive Odometer -**  
Displays total miles travelled by locomotive.  
Updates once per second.
- **Locomotive Road Number -**  
Appears to right of odometer.
- **Rear -**  
Brake pipe air pressure at rear of train, in PSI (pounds per square inch), as transmitted by EOT (end of train) device. Data updates once per second.

### **Speedometer on Figure 2-7 screen (on page 2-12)**

This area, illustrated by Figure 2-8, page 2-13, includes the locomotive speedometer, consisting of an oval gauge and the corresponding digital locomotive speed display. Speedometer indicates locomotive speed in MPH, updated every half second. Scale divisions are 5 MPH apart.

The scale above the overspeed limit (penalty brake zone) is red; the warning speed zone (below penalty brake zone) is yellow. When the overspeed detection system is disabled, the entire scale is white.

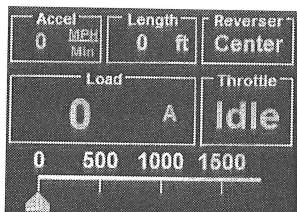


F51124

**Figure 2-8. Speedometer**

### **Upper Right Corner of Figure 2-7 screen (on page 2-12)**

This area, illustrated by Figure 2-9, includes the indicators listed after the illustration.



F80007

**Figure 2-9. Upper Right Corner of Screen**

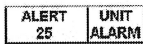
- **Accel -** Locomotive acceleration in miles per hour, per minute.  
Data updates once per second.



- **Length** - Train length, in feet - previously measured or entered by crew. Data updates once per second.  
See "Length Counter Functions," page 2-22, for more information.
- **Reverser** - Directional handle (reverser) setting: Forward, Centered, or Reverse.  
Data updates once per second.
- **Load** - The value of traction motor current through 1 TM based on the average current through all motors.
- **Throttle or Dyn.Brake** -  
Throttle handle setting (IDLE or TN, throttle notch),  
**or**  
Dyn. Brake handle setting (DB% of max.).  
Data updates once per second.

### **Warning Indicator Strip on Figure 2-7 screen (page 2-12)**

This area, illustrated by Figure 2-10, includes the indicators below. They are Off, except as noted.



F43163

**Figure 2-10. Warning Indicator Strip**



This white indicator lights to notify or warn the engineer of various conditions, some of which can be very dangerous.



This orange indicator lights whenever an penalty or emergency brake application occurs - locomotive power/ dynamic brake operation is also interrupted.

To restore locomotive power/ dynamic brake operation after safety control or emergency brake conditions end, reset pneumatic control: set throttle in IDLE, then set automatic brake in EMER (emergency) for a full minute, then set automatic brake in REL (release).

**DYN BRAKE** This yellow indicator flashes On and Off when dynamic brake current is excessive on this locomotive or on any locomotive trainlined to it. If DYN BRAKE indicator flashes, reduce dynamic brake handle setting immediately to help prevent equipment damage.

If DYN BRAKE indicator does not stop flashing when dynamic brake handle setting is reduced, or if indication repeats, set engine control panel DYNAMIC BRAKE switch on affected locomotive in CUT OUT. That locomotive's power operation will not be affected, but its dynamic braking will not function, and message - NO DYNAMIC BRAKE - DYNAMIC BRAKE IS CUT OUT will display on that locomotive.

**ALERT 25** This red indicator flashes, then lights steadily as the alerter system countdown progresses. The countdown (in seconds) displays in the ALERT indicator, under the RESET label.

**UNIT ALARM** This yellow indicator lights whenever the FIRE system has sounded the audio warning device, whether for a FIRE system warning or because another system has requested the warning.

If alarm can be silenced, yellow ALARM SILENCE key appears automatically.

The UNIT ALARM indicator remains lit until the cause of the warning no longer exists, even if the engineer silences the audio warning device through the FIRE system.

**AB FAIL** This red indicator flashes for five seconds, then lights steadily, when the air brake system has experienced a failure, or when communication between the air brake system and the FIRE system has failed.

**Note:** In some circumstances when the air brake system has a communication problem, the blue INVLD DATA indicator lights at the AB FAIL spot on the FIRE screen.

**REAR  
EMER** This indicator shows different text with different background colors, indicating various HOTD (head of train device) and EOTD (end of train device) conditions:

**INVLD DATA** on blue background: No communication between HOTD and EOT.

**HOTD COMM** on yellow back-ground: Communication problem between the HOTD and the EOTD occurred during HOTD self-testing at system startup.

**REAR EMER** on red background: HOTD has communicated a rear emergency brake application request to the EOTD.

**VALVE FAIL** on yellow background: EOTD's rear emergency brake valve has failed.

**FR NO COMM** on yellow background: HOTD to EOTD communication is faulty.

**DEAD BATT** on yellow background: EOTD battery is dead.

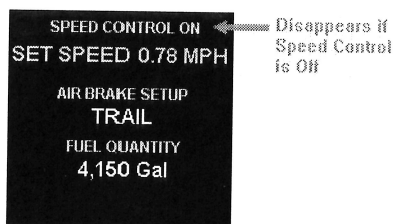
**RF NO COMM** on yellow background: EOTD to HOTD communication is faulty.

**LOW BATT** on yellow background: EOTD battery charge is low.

**EOT  
MOVE** This white indicator lights when the EOTD detects that the last car is moving. If the EOTD is the type that monitors and reports direction of movement to the HOTD, then when the last car begins moving, the indicator label is **EOT FWD** or **EOT REV**, depending on direction of movement. After 20 seconds moving forward, the indicator label changes to **EOT MOVE**.

### Misc. Status Area of Figure 2-7 screen (pg. 2-12)

This area of the screen includes the indicators shown in Figure 2-11, next.



F51126

**Figure 2-11. Misc. Status Area**

- **SPEED CONTROL ON, & SET SPEED -**

Although not shown in Figure 2-11, this indicator appears above the FUEL QUANTITY indicator when the speed control system is On. The set speed, in MPH, appears directly below the SPEED CONTROL ON indication.

- **FUEL QUANTITY** - Indicates number of gallons remaining in this locomotive's fuel tank, provided that FUEL GAUGE breaker is closed.
- **AIR BRAKE SETUP** - Indicates how air brake control system is set up:

LEAD CUT IN, or

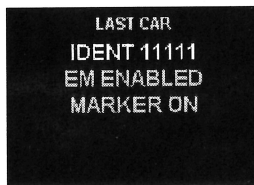
LEAD CUT OUT, or

TRAIL, or

? - if lead/trail or cut in/cut out information from brake control system is missing or invalid.

### Last Car (EOT) Area of Figure 2-7 screen (pg. 2-12)

This area of the screen includes the **LAST CAR** (end of train) indicators shown in Figure 2-12, next.



F43165

**Figure 2-12. Last Car (EOT) Area**

- **IDENT** - EOT device identification no.
- **EM TEXT:**
  - TEXT** = **ONE WAY** (in green) if EOT device is one-way type [cannot receive emergency brake command from HOT (head of train) device].
  - TEXT** = **ENABLED** (in green) if EOT device is two-way type (receives emergency brake command from HOT device) and system is armed to current EOT device identification no.
  - TEXT** = **DISABLED** (in yellow) if system is not armed to current EOT device identification no.
- **MARKER ON or OFF** -  
EOT device marker light status as communicated to HOT device.

**Note:** EOT MOVE indicator appears on different FIRE screen area - See Figure 2-10, page 2-14.

### Icon Indicators Area on Figure screen (page 2-12)


Any or all of the icons appearing next can appear on the right central part of the screen.





This blue icon appears when the windshield **DEFOGGER** has been activated from the CLIMATE CONTROL menu (CLIMATE CONTROL is selected from FIRE Main Menu). Defogger circuit will not operate unless HEATED WINDSHIELD breaker is closed.



This blue icon appears when the **HORN** is sounded by operating either the engineer's workstation HORN switch or the conductor's HORN switch.

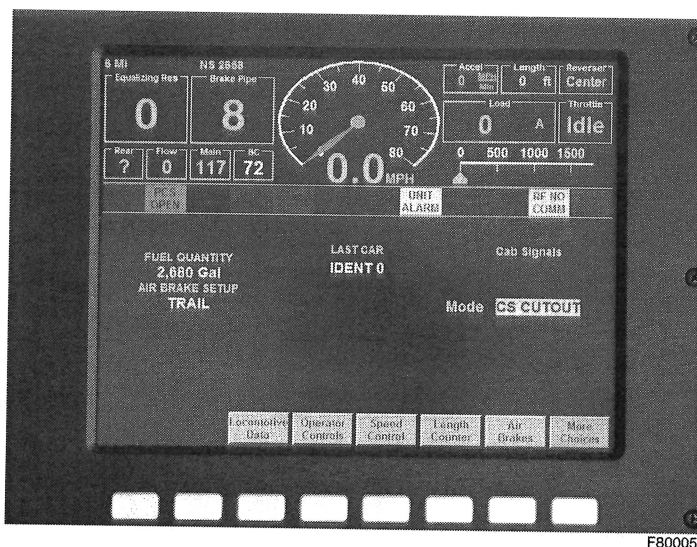
 This blue icon appears when the engineer rings the locomotive **BELL** by operating the bell switch or by operating the horn switch. It also appears if the conductor operates the horn switch.

 This yellow icon appears whenever the EM2000 locomotive computer is activating the sanding magnet valves - in response to LEAD TRUCK SAND switch operation, MANUAL SAND switch operation, automatic wheel slip control, automatic wheel creep control, or emergency braking.

 This yellow icon appears when the fuel level is too low on this locomotive.

### **FIRE Main Menu Area of Figure 2-7 screen (page 2-12)**

Figure 2-13, next, illustrates the FIRE Main Menu page 1 keys available on the engineer's FIRE panel when it is set up in the operating mode.



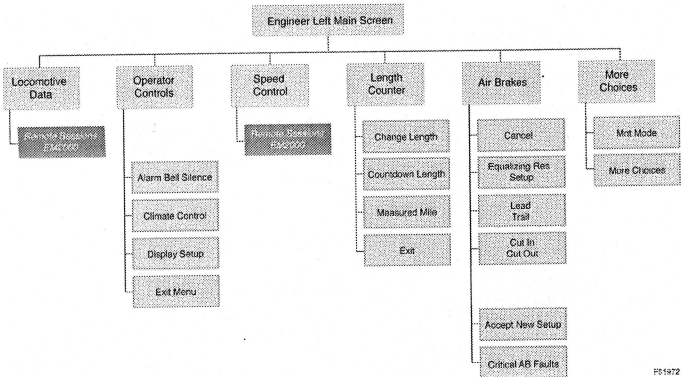
**Figure 2-13. FIRE Main Menu Area**

Pressing the *More Choices* key on page 1 of the engineer's FIRE Main Menu, Figure 2-13, causes Main Menu page 2 keys to appear, Figure 2-14. Similarly, if *More Choices* is pressed on page 2, page 1 re-appears.



F52602

Figure 2-14. Main Menu Keys



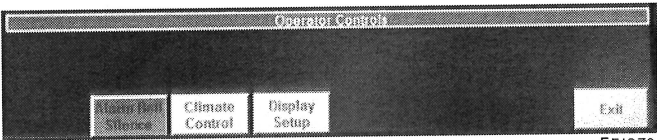
F51972

Figure 2-15.Main Screen Key Hierarchy of Functions

The following paragraphs describe the available FIRE Main Menu functions in more detail.

**Operator Controls Menu**

Pressing the Operator Controls key on page 1 of the FIRE Main Menu, Figure 2-13, page 2-19, brings up the Operator Controls menu, Figure 2-16, next.



F51370

Figure 2-16. Operator Controls Menu

The Operator Controls menu selections are described next.

### **Alarm Bell Silence**

If the locomotive alarm is ringing, and the fault that triggered the alarm is silenceable, pressing the *Alarm Bell Silence* key silences the alarm bell.

### **Display Setup**

Pressing the *Display Setup* key on the Operator Controls Menu brings up the *Display Setup Control* keys, Figure 2-17.



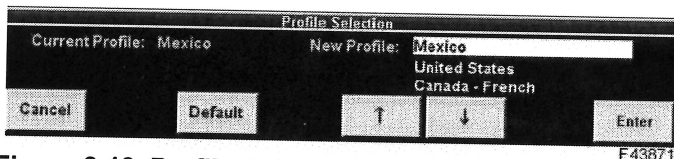
**Figure 2-17. Display Setup**

F52583

The *Brighter* and *Dimmer* keys control screen illumination. The existing screen illumination level displays in the box above the *Brighter* and *Dimmer* keys - 100% is the brightest. Each *Brighter* or *Dimmer* key press changes the level 5%.

Pressing the *Exit* key returns the screen to the Operator Controls menu, page 2-20.

Pressing the **Change Profile** key brings up the *Profile Selection* screen, Figure 2-18.



**Figure 2-18. Profile Selection**

F43871

The profile selected sets up the following formats on all FIRE display screens.

- Language
- Date
- Time
- Time Zone
- Units of Measure (Example - MPH vs. KPH)

**Note:** All formats listed above are set at the same time. No single format listed above can be changed by itself through the Profile Selection function.



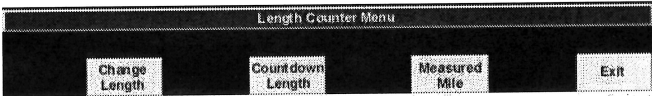
Press the arrow keys to highlight the desired profile, then press the *Select* key to activate it.

Pressing the *Default* key immediately activates the default display profile, which is the United States profile.

Pressing the *Exit* key returns the display to the Display Setup screen, Figure 2-17, page 2-21.

**Length Counter Functions**

If a *Countdown Length* or *Change Length* function is not in progress, pressing the *Length Counter* key on page 1 of the FIRE Main Menu, Figure 2-13, page 2-19, brings up the Length Counter menu, Figure 2-19.



F43193

**Figure 2-19. Length Counter Menu**

If a *Change Length* or *Countdown Length* function is in progress, pressing the FIRE Main Menu *Length Counter* key immediately restores the corresponding screen (*Change Length* or *Countdown Length*).

**Change Length Functions**

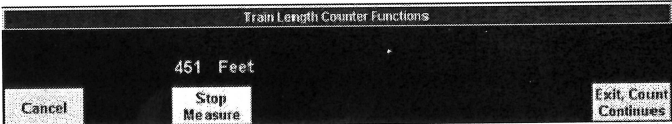
Pressing the *Change Length* key on the Length Counter Menu brings up the *Change Length Menu*, Figure 2-20, page 2-22.



F43194

**Figure 2-20. Change Length Menu**

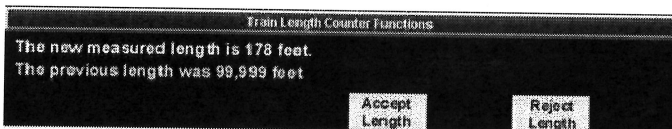
Pressing the *Measure Length* key on the *Change Length Menu* causes FIRE to open the *Train Length Counter Functions* window, Figure 2-21, and resets the train length counter displayed there to zero.



F43195

**Figure 2-21. Train Length Counter Functions**

- As the train moves, the length counter displayed on the *Train Length Counter Functions* window counts upward until the engineer presses the *Cancel* key or the *Stop Measure* key, or until the count exceeds 22966 Feet (7000 meters).
- If the engineer presses the *Cancel* key, the count is aborted and the *Train Length Counter Functions* window returns to the display.
- If the engineer presses the *Exit, Count Continues* key, the counter continues counting upward, and the *Train Length Counter Functions* window is replaced by the FIRE Main Menu, Page 1.
- If the engineer presses the *Stop Measure* key, the *Train Length Counter Functions* window becomes the *Measurement Preview Screen*, next.



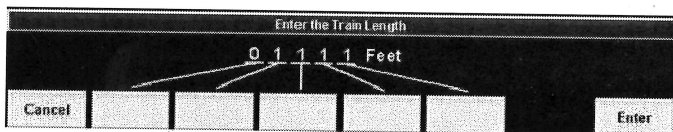
F43196

### Figure 2-22. Train Length Counter Functions

The *Measurement Preview Screen*, above, enables the engineer to compare the previous and new measured lengths before accepting the new one.

- If the engineer presses the *Accept Length* key, the *new measured length* is the new train length. However, the FIRE system does not accept new train lengths that are under 164 Feet (50 meters).
- If the engineer presses the *Reject Length* key, the *new measured length* is discarded, and the *Change Length Menu* returns to the screen.

Pressing the *Enter Length* key on the *Change Length Menu*, Figure 2-20, page 2-22, causes FIRE to open the *Enter the Train Length* window, Figure 2-23.



F43197

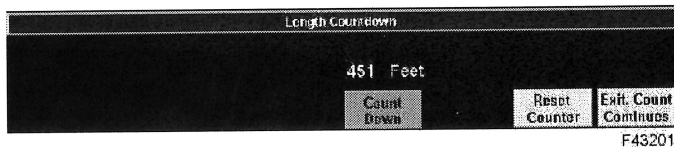
### Figure 2-23. Enter The Train Length Function

Enter train length by repeatedly pressing the appropriate digit keys. Each key press raises that digit by one. If a digit is 9 on the screen, pressing the key for that digit changes the value to 0.

- If the keyed-in length is less than 164 Feet (50 meters) or over 22966 Feet (7000 meters), the *Enter* key is disabled, and the phrase *Invalid Length* displays over the *Enter* key.
- If the engineer presses the *Cancel* key, the keyed-in length is discarded.
- If the engineer presses the *Enter* key, and the keyed-in length is in the right range (see above), FIRE accepts the keyed-in length as the train length.

### **Countdown Length Function**

Pressing the *Countdown Length* key on the Length Counter Menu, page Figure 2-19, page 2-22, opens the *Length Countdown* window, Figure 2-24, page 2-24, and starts the countdown, unless it is already in progress. The countdown length appearing above the *Countdown* key on Figure 2-24 is initially set at the previously entered or measured train length, unless a length countdown is already in progress.



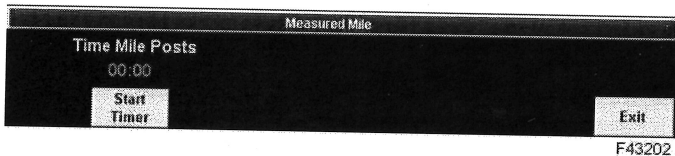
F43201

**Figure 2-24. Length Countdown Function**

- If the engineer presses the *Count Down* key, the countdown is aborted and the *Length Counter Menu*, Figure 2-19, page 2-22, returns to the screen.
- If the engineer presses the *Reset Counter* key, the countdown length (above *Count Down* key) resets to the previously entered or measured train length.
- If the engineer presses the *Exit, Count Continues* key, the countdown continues and the screen returns to page 1 of the FIRE Main Menu.

### **Measured Mile (Speed Check) Function**

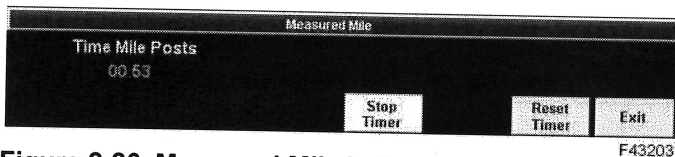
Pressing the *Measured Mile* key on the Length Counter Menu, page Figure 2-19, page 2-22, opens the *Measured Mile* entry screen, Figure 2-25, next. The elapsed time indicator appearing above the *Start Timer* key on Figure 2-25 is initially set at 00:00 (zero minutes, zero seconds).



**Figure 2-25. Measured Mile Function**

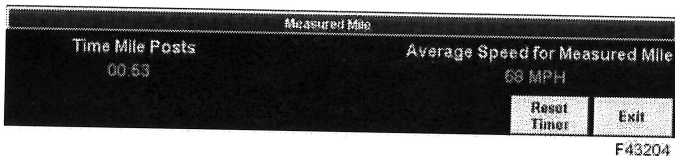
- To start the measured (timed) mile process, the engineer presses the *Start Timer* key as the locomotive passes a milepost.

The timer starts running and a *Stop Timer* key appears on the *Measured Mile in Progress* screen, Figure 2-26.



**Figure 2-26. Measured Mile In Progress**

- When the locomotive passes the next milepost, the engineer presses the *Stop Timer* key on the *Measured Mile in Progress* screen. The timer stops and the *Measured Mile Results* screen, Figure 2-27, appears.

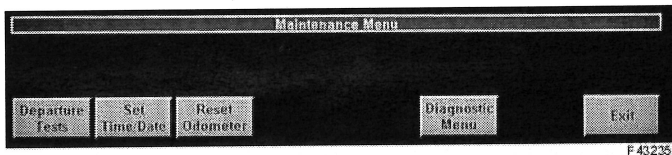


**Figure 2-27. Measured Mile Results**

- Pressing the *Reset Timer* key while the measured mile is in progress (Figure 2-26) or after it completes (Figure 2-27) resets and restarts the timer: it restarts the measured mile speed check process.

### Maint. Mode

Pressing the *Maint. Mode* key on page 2 of the FIRE Main Menu, Figure 2-14, page 2-20, brings up the *Maintenance Menu*, Figure 2-28.



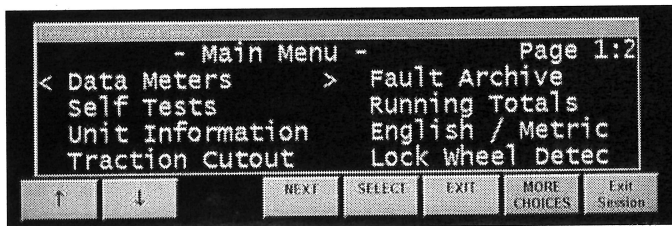
F 43235

**Figure 2-28. Maintenance Menu**

Of the several selections available on the *Maintenance Menu*, **only** *Departure Tests* should be used by the locomotive crew. See “Departure Tests” starting on page 3-14 for directions.

### Locomotive Data Function

Pressing the *Locomotive Data* key from the FIRE Main Menu, Figure 2-15, page 2-20, brings up the EM2000 locomotive computer Main Menu in the *Locomotive Data Remote Session* window, as shown in Figure 2-29.



F43159

**Figure 2-29. EM2000 Main Menu**

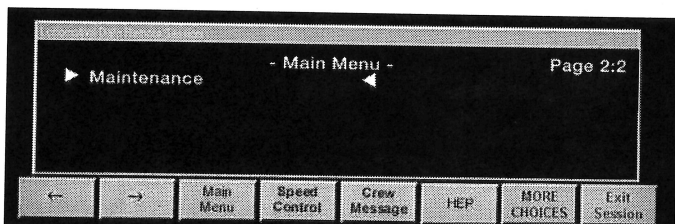
Pressing the arrow keys moves the cursor up and down through the EM2000 Main Menu choices. (The < > symbol pair is the cursor.)

Pressing the *NEXT* key at EM2000 Main Menu Page1:2 brings up EM2000 Main Menu Page 2:2, which only offers one additional menu choice - *Maintenance*. (*Maintenance* selection does not provide any functions for use of locomotive crew.)

Pressing the *SELECT* key activates the EM2000 Main Menu choice at the cursor.

Pressing either the *EXIT* key or the *Exit Session* key at the EM2000 Main Menu (page 1 or 2) returns the FIRE Main Menu page 1 screen, Figure 2-15, page 2-20, to the panel.

Pressing the *MORE CHOICES* key at page 1 or 2 of the EM2000 Main Menu changes the key labels to those shown in Figure 2-30, next.



F80023

**Figure 2-30. EM2000 Main Menu**

Pressing the right and left arrow keys at the Figure 2-30 screen shifts the cursor back and forth between the two Main Menu columns.

Pressing the *Main Menu* key at the Figure 2-30 screen does nothing except refresh the screen.

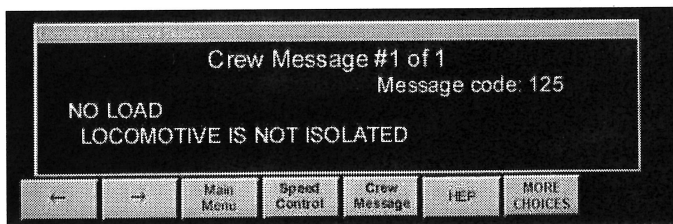
Refer to "SPEED CONTROL OPERATION," page 3-42, for information about using the *Speed Control* key at the Figure 2-30 screen. Pressing the *HEP* key at the Figure 2-30 screen does nothing on this locomotive.

Pressing the *MORE CHOICES* key at the Figure 2-30 screen returns the Figure 2-29, page 2-26, screen to the panel.

Pressing the *Crew Message* key at the Figure 2-30 screen displays the EM2000 crew message screen in the Locomotive Data Remote Session window, Figure 2-31, page 2-28.

**Note:** Each FIRE screen and each EM2000 crew message has a pre-assigned priority (importance). If a crew message is more important than whatever else is displaying, the Locomotive Data Remote Session crew message window opens automatically, without *Crew Message* key operation, and overrides the previous screen.

When the Locomotive Data Remote Session crew message window opens, the highest priority crew message displays. If there is another crew message, of lower priority, that has not been viewed yet, pressing the *NEXT* key displays it. (In some cases, it may be necessary to press the *MORE CHOICES* key before the *NEXT* key appears.



F43243

### Figure 2-31. Crew Message #1 of 1

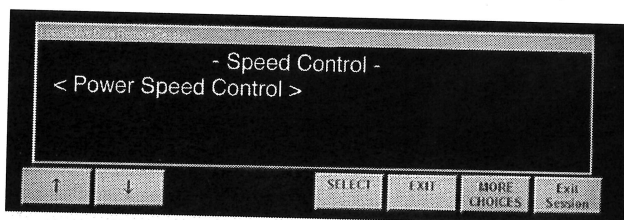
Notice the *Crew Message #1 of 1* line at the top of Figure 2-31. If more unviewed EM2000 crew messages were stored, for example 7 more, the line would read - *Crew Message #1 of 8*. The *Message code* on the Figure 2-31 screen is an easy identification number that enables the specific message to be conveyed to others briefly.

Besides *NEXT*, certain other key labels appear on EM2000 crew message screens:

- *RESET* - Appears when message is Fault/Lockout type. Resets certain faults and lockouts, and deletes associated crew messages.
- *DISABLE* - Used for cutting out all traction motors on a truck.
- *PREVIOUS* - Appears when there is at least one more important undisplayed EM2000 crew message.

### **Speed Control Function**

Pressing the *Speed Control* key from the FIRE Main Menu, Figure 2-15, page 2-20, brings up the EM2000 *Speed Control* menu, Figure 2-32, next.



F80024

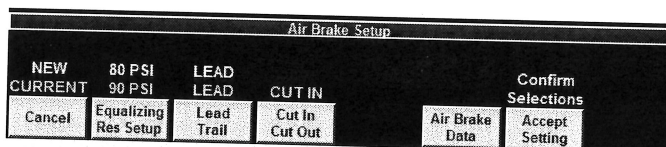
**Figure 2-32. Speed Control**

Use the arrow keys to set the cursor on *Power speed control*. Then press *SELECT* key.

For further information, see the Speed Control procedure on page 3-42.

### **Air Brakes Function**

Pressing the *Air Brakes* key from the FIRE Main Menu, Figure 2-15, page 2-20, brings up the *Air Brake Setup* screen, Figure 2-33.



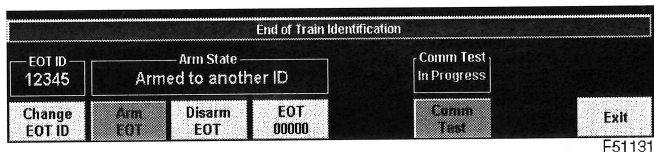
F51130

**Figure 2-33. Air Brake Setup**



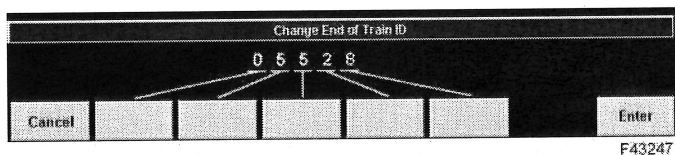
## **EOT ID Function**

Pressing the *EOT ID* key from the FIRE Main Menu, Figure 2-30, page 2-27, brings up the *End of Train Identification* screen, Figure 2-34, next



**Figure 2-34. End of Train Identification**

Pressing the *Change EOT ID* key on the *End of Train Identification* screen, Figure 2-34, brings up the *Change End of Train ID* screen, Figure 2-35, next.



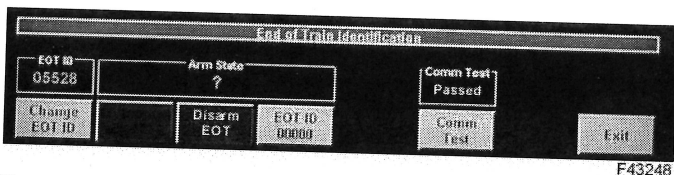
**Figure 2-35. Change End Of Train ID**

Press any digit key (blank keys on Figure 2-35) to raise the displayed value for that digit by one. If the displayed value is 9, pressing the key changes it to 0.

When the desired *EOT ID* number displays, press the Enter key. The *End of Train Identification* screen, Figure 2-34, returns, but with the desired *EOT ID* number displaying.

Pressing the *Comm Test* key at the *End of Train Identification* screen checks communications with the new EOT device. If the test is successful, *Comm Test Passed* appears and the *Arm EOT* key appears.

Pressing the *Arm EOT* key arms the EOT device, causes *Armed* to display in the *Arm State* box, deletes the *Arm EOT* key, and causes the *Disarm EOT* key to appear, Figure 2-36. Pressing the *EOT ID 00000* key disarms the EOT device and resets the *EOT ID* number to 00000



**Figure 2-36. End of Train Identification**

### **Locomotive Monitor Function and Remote Fuel Monitoring**

None of the selections available on the *Locomotive Monitor Menu* should be used by the locomotive crew.

Pressing the *Locomotive Monitor* key on page 2 of the FIRE Main Menu, Figure 2-30, page 2-27, brings up the *Locomotive Monitor Menu*.

## **AIR BRAKE EQUIPMENT**

The locomotive is equipped with an electronically controlled air brake system, which includes:

- The electrical air brake controller on the engineer's workstation. The controller includes the independent and automatic brake handles.
- The electropneumatic control unit, which controls the pneumatic brake lines.

All air brake setup and monitoring functions available to the crew are provided by the FIRE system.

The air brake controller provides the independent and automatic brake control functions. The handles for these brake functions are arranged in a standard workstation configuration. Each handle attaches to an electrical device that provides input signals to the air brake computer. Handles are operated in forward-backward arcs, releasing the brakes at the backward settings (toward engineer).

**Note:** The following text assumes that the train brake system is cut in and fully charged.

# Air Brake Controller

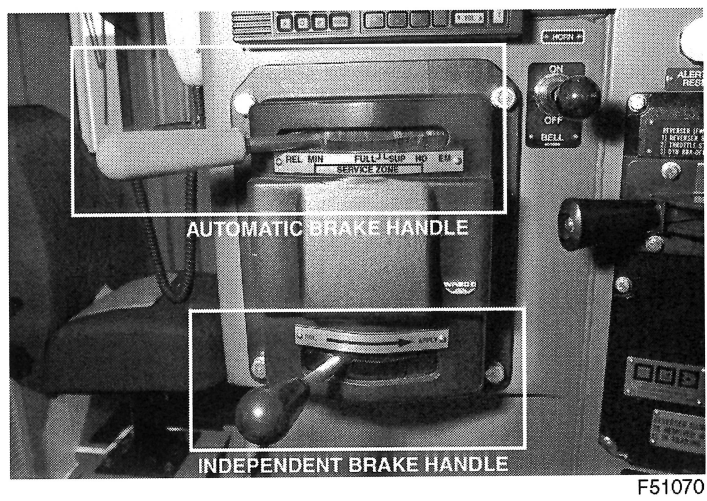
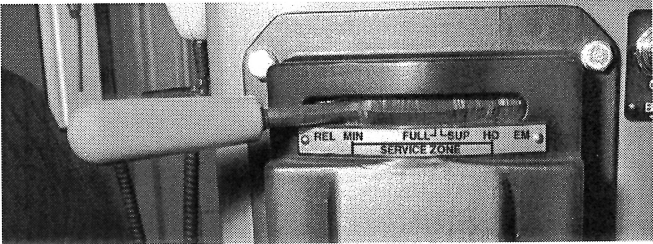


Figure 2-37. Air Brake Controller

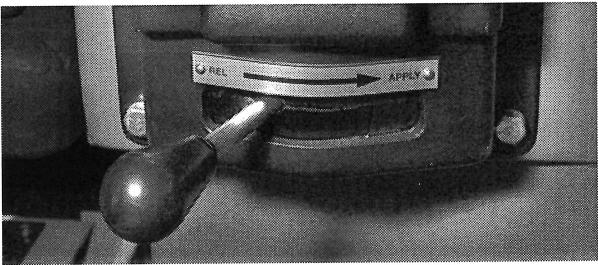
F51070



REL - Release	FULL - Full Service
MIN - Minimum Reduction	SUP - Suppression
HO - Handle OFF	EM - Emergency

F51121

Figure 2-38. Automatic Brake Handle



F51122

Figure 2-39. Independent Brake Handle

## **AUTO (Automatic) BRAKE Handle**

The AUTO (automatic) BRAKE handle controls application and release of locomotive and train air brakes. The automatic brake function is a "pressure maintaining type," holding brake pipe constant at the selected pressure against normal brake pipe leakage. Operating positions are detented for positive location.

### **Automatic Brake Handle Settings:**

- **REL (Release):**  
(Handle at back-most detent.)  
Charges brake equipment and releases locomotive and train brakes.
- **MIN (Minimum Reduction):**  
(Handle at first detent forward of the REL setting.)  
Provides minimum braking effort (7 psi reduction).
- **Service Zone:**  
(Handle between REL and FS.)  
As handle moves forward - toward front of locomotive - through service zone, air brake effort (brake pipe reduction) increases.
- **FS (Full Service):**  
(Handle at second detent forward of REL.) Provides full service braking.
- **SUP (Suppression):**  
(Handle in the third detent forward of REL setting.) Like FS setting, provides full service braking, plus suppresses overspeed control and safety control (penalty) applications. Also enables resetting from penalty applications.
- **HO (Handle Off):**  
(Handle at fourth detent forward of REL setting.)  
Sets up locomotive air brake system for trailing-in-consist or dead-in-train service.
- **EMER (Emergency):**  
(Handle at forward-most detent, toward front of locomotive.) Initiates emergency braking application. Also used for resetting after penalty (safety) and emergency brake applications.

## **IND (Independent) BRAKE Handle**

This handle controls locomotive air braking independently (without regard to automatic brake handle setting). This control is self-lapping - in the Application Zone, it holds the brakes applied at a value corresponding to the handle setting. There are no detented settings for this handle.

### **Independent Brake Handle Settings:**

- **REL (Release):**  
(Handle at back-most point.) Releases locomotive brakes, provided that automatic brake handle is also in REL.
- **Application Zone:**  
(Handle between REL and FULL.) As handle moves forward - toward front of locomotive - through zone, locomotive air brake effort increases.
- **FULL:**  
(Handle at extreme forward point.) This setting provides full locomotive air brake effort.
- **BAIL-OFF:**  
Depressing the handle in any position will cause a release of the locomotive brakes. This action includes the brakes on any locomotive connected in consist. To ensure a complete release, the handle should be held depressed for six (6) seconds per locomotive in the consist.

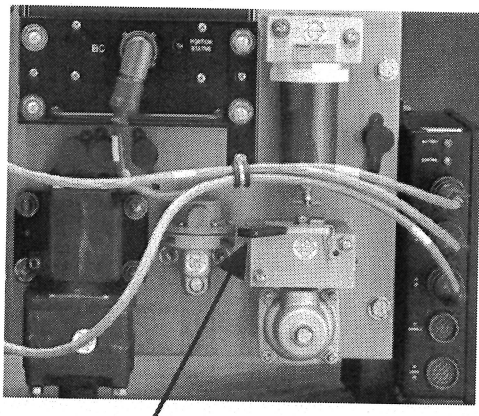
**Note:** Depressing the handle while the handle is in the application zone bails off (releases) any automatic brake application existing on the locomotive(s) down to the level set by the IND BRAKE handle.

## **Dead Engine Cut Out Cock**

The dead engine cutout cock mounts in the cab subbase, on the engineer's side. For normal locomotive operation this valve is set **CLOSED**.

This valve is set **OPEN** when the locomotive is to be hauled **dead-in-train**. When open, it limits braking effort by setting maximum brake cylinder pressure at 25psi (main reservoirs charge through a 25psi regulator). The locomotive brakes like a freight car.

**Note:** The diesel engine must be shut down, main reservoir pressure must be drained below 25psi, and all locomotive MU brake hoses must be disconnected before opening the cutout cock for dead-in-train operation. To prevent overcharging the reservoirs, leave the MU brake hoses disconnected.



DEAD ENGINE CUT-OUT COCK

F51166

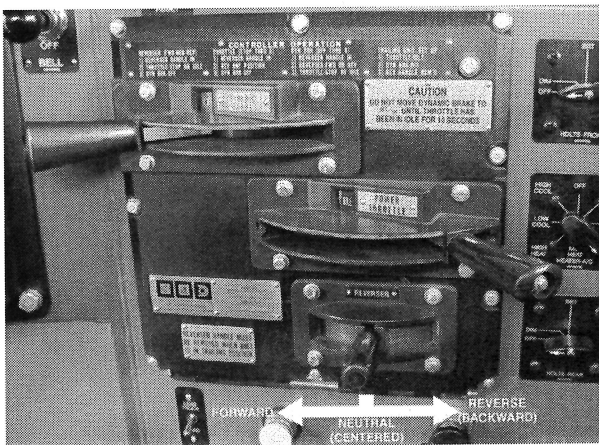
**Figure 2-40. Dead Engine Cut Out Cock**

### **Locomotive Controller**

(See Figure 2-3, page 2-5, for location.) The locomotive controller has three operating handles, which control three different functions. The REVERSER (directional handle), on the bottom, controls the direction of locomotive traction (propulsion) and dynamic braking. The THROTTLE handle, in the center, controls locomotive traction effort levels, while the upper DYNAMIC BRAKE controls locomotive dynamic brake effort levels.

**Note:** See “Mechanical Interlocks on the Controller,” page 2-38, for important information.

## REVERSER (Directional Handle)



F51072

### Figure 2-41. Reverser Operation

The REVERSER has three detent settings: Neutral (center), FORWARD, REVERSE (backward).

When the handle is in FORWARD (toward front end of locomotive) control circuits set up to move the locomotive in that direction.

When the handle is set in REVERSE (toward the long hood end), control circuits set up to move the locomotive in that direction.

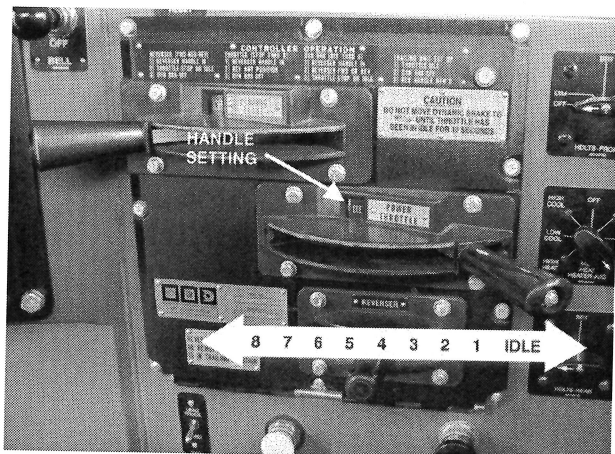
### CAUTION

Damage to traction motors in trailing DC locomotives may occur if REVERSER (directional handle) is moved from FORWARD to REVERSE or REVERSE to FORWARD while locomotive is moving - change REVERSER setting only when locomotive is completely stopped.

If locomotive will trail in consist, remove the REVERSER.

**Note:** Also see "Mechanical Interlocks on the Controller," page 2-38, for important information.

## Throttle Handle



F51074

### Figure 2-42. Throttle Operation

The throttle handle, Figure 2-42, has two operating modes; THROTTLE, and STOP. An illuminated window above the handle displays the handle setting.

### Throttle Operation

The throttle (power) sector has nine detent settings; IDLE and notches 1 through 8. From IDLE, move the handle to the left to increase engine speed and locomotive power with each new notch.

**Note:** Also see “Mechanical Interlocks on the Controller,” page 2-38, for important information.

### Stop Operation

Moving the throttle handle from the IDLE position to the right into the STOP position will cause the diesel engine to shut down. Note that all trainlined locomotives will also be shut down by this action. The throttle handle will have to be returned to the IDLE position to enable engine starting.



## Dynamic Brake Handle

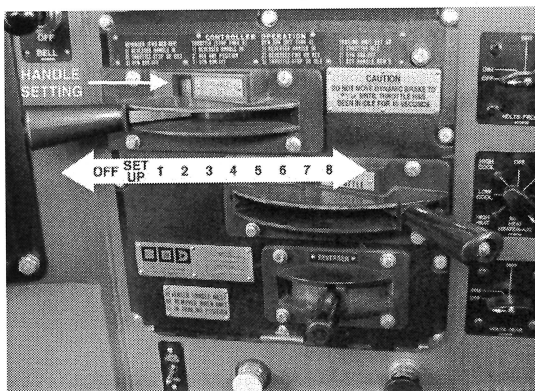
The dynamic brake handle, Figure 2-43, has two detent settings, OFF and SET-UP, and a continuous operating range, 1 through 8, through which the handle moves freely - without notching. To initiate dynamic braking, the engineer pushes the handle forward from OFF to SET-UP.

### CAUTION

During operation as lead with trailing DC locomotives, hold the handle in IDLE for 10 seconds before setting it in SET-UP. This precaution prevents a sudden surge of braking effort with possible train slack run-in and prevents DC traction motor flash-overs.

To increase the dynamic braking effort, the engineer moves the handle to the right progressively to higher- numbered DYN BRAKE settings. The FULL 8 setting provides the greatest dynamic braking effort.

**Note:** Also see "Mechanical Interlocks on the Controller," page 2-38, for important information.



F51075

**Figure 2-43. Dynamic Brake Operation**

## Mechanical Interlocks on the Controller

### ***Reverser Centered (Neutral) -***

- Dynamic Brake handle is locked in OFF.
- Reverser can be removed from controller only if the Throttle handle is in IDLE *and* the Dynamic Brake handle is in OFF.

***Reverser removed from controller -***

- Throttle handle is locked in IDLE.
- Dynamic Brake handle is locked in OFF.

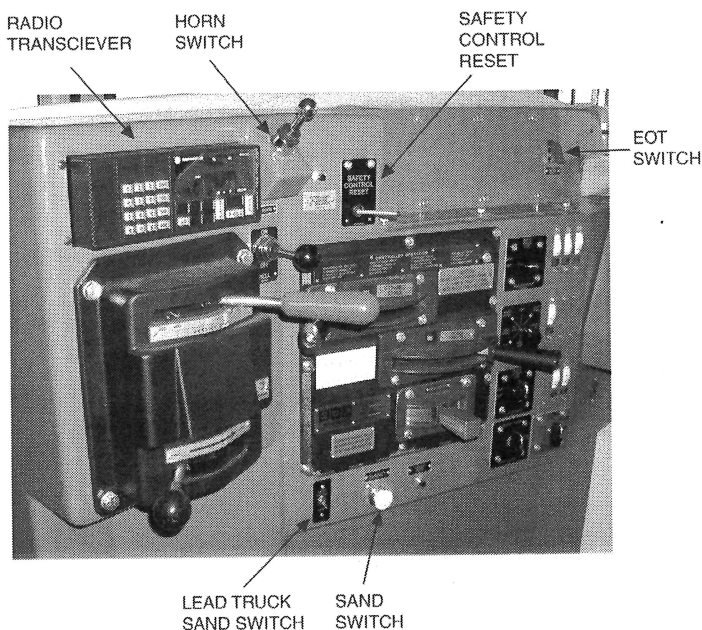
***Throttle handle in throttle position -***

- Reverser is locked in FORWARD or REVERSE
- Dynamic Brake handle is locked in OFF.

***Dynamic Brake handle in SetUp or brake position -***

- Reverser is locked in FORWARD or REVERSE.
- Throttle handle limited to IDLE or STOP position.

## MISCELLANEOUS CONTROLS



F80025

**Figure 2-44. Miscellaneous Controls**

### RADIO TRANSCEIVER

The voice radio transceiver includes the controls that are necessary to communicate with wayside installations as well as with other trains. A handset is located at the engineer's workstation. The conductor's workstation is equipped with a handset and speaker only.

### HORN Switch

The Horn switch is located above and to the right of the Air Brake Controller, Figure 2-44. Moving this switch in any direction sounds the locomotive air horn and locomotive bell until the pushbutton is released. This action also initiates the locomotive bell. (The horn and bell icons light on the FIRE screen while the associated devices are sounding.) A horn pushbutton is also provided at the conductor's workstation.

## BELL Switch

This switch is located beneath the horn switch as shown in Figure 2-44, page 2-40, and operates the locomotive signal bell. Movement of the switch latches it On, ringing the locomotive bell and lighting the bell icon on the engineer's right FIRE screen. A second movement unlatches the switch, ending bell operation and indication.

**Note:** Operating the engineer's HORN switch also activates the locomotive bell. If the bell is activated that way, it can only be silenced by movement of the BELL switch.

## ATTENDANT CALL Switch

Pressing this pushbutton switch, located to the right of the horn and bell controls as shown in Figure 2-44, page 2-40, sounds the audio warning device on this locomotive and on all trainlined units in consist.

## ALERTER RESET

Located on the upper part of the workstation, the switch resets the alerter system when activated. Note that performing any of several other actions also resets the system. See "ALERTER SYSTEM OPERATION," page 3-45, for more information.

## EOT REAR EMERG BRAKE Switch

This momentary toggle switch is mounted on the upper right corner of the engineer's workstation, as shown in Figure 2-44, page 2-40. A safety guard covers this switch to prevent accidental use. Operating the switch initiates an emergency brake application at the rear end of the train provided that all three of the following are true:

- Locomotive computer EM2000 is operating.
- FIRE system is operating.
- EOT unit is installed on the last car and the system is armed.

## **LEAD TRUCK SAND Switch**

The Lead Truck Sand switch is located below the Controller, Figure 2-44, page 2-40. Moving this switch to the Up position will limit sanding in manual mode to the Lead truck only. (The sand icon lights on the FIRE screen while the sanders are working.)

## **SAND Switch**

The Sand switch is located below the Controller, Figure 2-44, page 2-40. Depressing this switch activates the locomotive sanders. Sanding is available up to 12 MPH in manual mode, and 15 MPH in manual mode with Lead Truck Sand switch in the Up position. Above these speeds, sanding is controlled by EM2000. (The sand icon lights on the FIRE screen while the sanders are working.)

# CONDUCTOR'S WORKSTATION



F51077

**Figure 2-45. Conductors Workstation**

## RADIO HANDSET & SPEAKER

This equipment operates with the voice radio that mounts on the engineer's workstation.

## EMERGENCY BRAKE VALVE

An emergency brake valve mounts on the face of the workstation, on the vertical surface to the right of the conductor. Opening the valve (lifting the handle) initiates an emergency brake application. The valve must be closed to enable recovery from an emergency brake application.

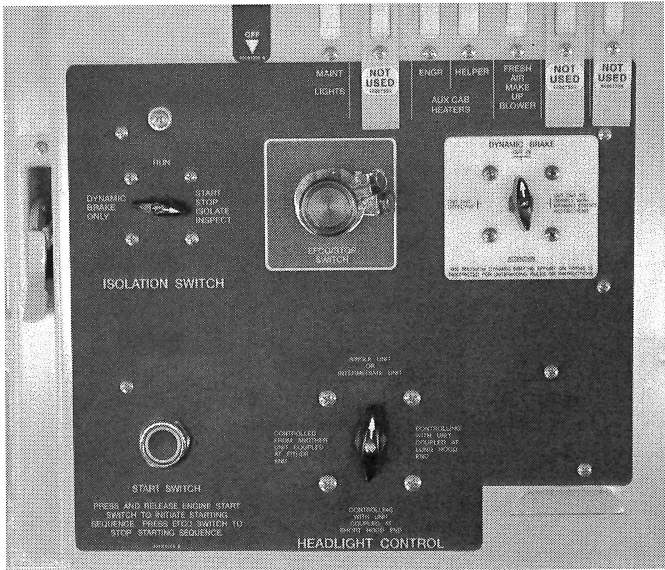
## HORN SWITCH

See description, on page 2-40.

## SPEEDOMETER

A speedometer is mounted on the face of the workstation, on the vertical surface to the left of the conductor.

# ENGINE CONTROL PANEL



F80026

**Figure 2-46. Engine Control Panel**

Located on the rear wall of the cab are the Engine Control Panel Figure 2-46 and the Circuit Breaker Panel (behind the Engine Control Panel). All High Voltage equipment and associated components are located in the Electrical Control Locker, which is accessed through a door located behind the cab on the right side of the locomotive.

## WARNING

Operating Personnel are cautioned to **KEEP OUT** of the electrical control locker unless specifically directed by maintenance personnel. High voltage is present within the electrical control locker during, and sometimes after, locomotive operation.

**Note:** There is no ground relay lockout reset switch. If it the ground relay locks out, it can only be reset through the FIRE system's Locomotive Data function. Follow applicable railroad rules.

Operator devices on this panel include:

## REMOTE HEADLIGHT CONTROL Switch

This switch enables the lead unit to control the headlight operation on the rear unit of the consist.

Set the switch according to locomotive status:

- On Single Locomotive or Lead Locomotive in Consist-
  - If locomotive is to operate without other locomotives, use SINGLE UNIT OR INTERMEDIATE UNIT.
  - For multiple locomotive service, with trailing locomotives coupled to No. 2 or long hood end of lead locomotive, use CONTROLLING WITH UNIT COUPLED AT LONG HOOD END.
  - For multiple locomotive service, with trailing locomotives coupled to No. 1 or short hood end of lead locomotive, use CONTROLLING WITH UNIT COUPLED AT SHORT HOOD END.
- On Intermediate Locomotives in Consist -
  - For locomotive operating between other locomotives in a multiple locomotive consist, use SINGLE UNIT OR INTERMEDIATE UNIT.
- On Trailing Locomotive in Consist -
  - For last locomotive in a multiple locomotive consist, use CONTROLLED FROM ANOTHER UNIT COUPLED AT EITHER END.

**Note:** Engineer's workstation HDLTS FRONT and HDLTS REAR switches control headlight On/Off and intensity functions. HDLTS circuit breaker on the circuit breaker panel must be On (lever Up) to enable other headlight controls.



## ISOLATION Switch

This rotary switch has three settings:

- START / STOP / ISOLATE
- RUN
- DYNAMIC BRAKE ONLY

Setting the switch in the START / STOP / ISOLATE position allows engine starting and shut-down. In this position, the locomotive will not develop tractive or dynamic braking effort. The engine runs at idle speed regardless of throttle handle setting. This limits automatic engine speedups beyond throttle 2, preventing hot oil from spattering personnel performing engine top deck inspection. This position will also silence alarms caused by NO POWER condition as determined by locomotive computer. Does not silence HOT ENGINE or TRACTION MOTOR alarm.

Moving the switch to the RUN position will allow the locomotive to respond to operator requests for tractive effort and dynamic brake operation.

The DYNAMIC BRAKE ONLY position will allow full dynamic brake operation, but the locomotive will not develop tractive effort.

**Note:** Positioning of the Isolation Switch will not affect other locomotives connected in multiple unit operation.

## DYNAMIC BRAKE CUT OUT Switch

This switch has the following settings:

- CUT IN
- CUT OUT - DEFECTIVE
- CUT OUT - RESTRICTED

Setting the switch in CUT IN enables locomotive computer EM2000 to initiate dynamic braking on the locomotive when requested by the engineer, provided that all other conditions are met.

Setting the switch in CUT OUT- DEFECTIVE blocks dynamic braking on this locomotive, but does not affect other locomotives in consist.

Setting the switch in CUT OUT- RESTRICTED *reduces* dynamic braking on this locomotive to comply with brake effort restrictions, but does not affect other locomotives in consist.

### **EFCO/ STOP (Engine Fuel Cut Off) Switch**

Pressing this large red pushbutton for approximately one second requests the locomotive computer to stop the diesel engine. Holding the button in for one second ensures that the locomotive computer recognizes the switch actuation. (The pushbutton can be released after one second.)

This switch is equipped with a mechanism to hold it actuated (in ENGINE FUEL CUT OFF setting) when desired. Diesel engine cannot start if switch is in ENGINE FUEL CUT OFF.

#### **To lock the EFCO/STOP switch in ENGINE FUEL CUT OFF:**

1. Press switch pushbutton and hold it depressed until end of next step.
2. Turn moveable part of holding mechanism clockwise until it completely covers stationary part of mechanism. (Pushbutton stays in when released.)
3. Pass lock shackle through lined-up holes in moveable and stationary parts of holding mechanism.
4. Lock the lock.

#### **To release the switch:**

1. Unlock and remove lock from holding mechanism.
2. Turn moveable part of holding mechanism counter-clockwise until spring pressure releases pushbutton.

## (ENGINE) START Switch

### CAUTION

**PREHEAT engine *before* starting it if:**

- Engine coolant water temperature is 50° F (10°C), or lower.

**PRELUBE engine before starting if any of the following conditions are true:**

- New engine installed in locomotive.
- Engine has just been overhauled.
- New oil filters have just been installed.
- Engine has been shut down for more than 48 hours.

**Failure to prelubricate engine when required may result in serious engine damage.**

**See Running Maintenance Manual for prelubrication instructions.**

Locomotive engine and equipment must be properly inspected and set up before engine is started. See Section 3 of this manual for instructions.

Momentarily pressing the START pushbutton starts the automatic diesel engine start sequence:

1. Turbo Lube pump is energized.
2. Engine is primed with fuel.
3. Alarm sounds for five seconds in engine room.
4. When alarm ends, starting motor engages engine ring gear and cranks diesel engine until it starts.
5. Starting motor disengages.

**Note:** Pushing the engine start button any time during the start sequence (except when the starter motor is engaged) will abort the start sequence.

## SLIDE SWITCHES

The following switches mount on the top portion of the engine control panel. Note that there are spare switches not used on all applications. To switch On a slide switch (close its contacts), slide the slider to the upper stop; to switch it Off (open its contacts), slide the slider to the lower stop.

### **MAINT LIGHTS Switch**

Controls the maintenance lights in the interior of the locomotive carbody.

### **FRONT MARKER LIGHTS Switch**

Controls the marker lights located on the front of the locomotive cab.

### **AUX CAB HEATER ENGR Switch**

Controls the operation of the auxiliary cab heater located on the engineer's cab sidewall.

### **AUX CAB HEATER HELPER Switch**

Controls the operation of the auxiliary cab heater located on the conductor's cab sidewall.

### **FRESH AIR MAKE UP BLOWER Switch**

This switch controls the cab fresh air make up blower motor, provided that the Auxiliary Power Converter is operating and the FRESH AIR M/U breaker is On (lever Up).

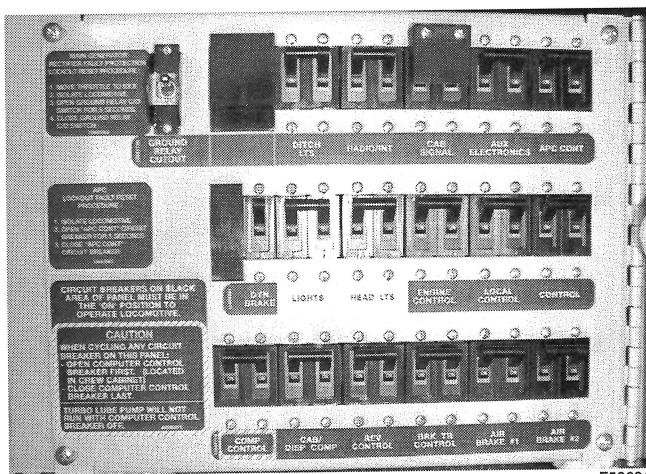
### **FLANGE LUBE DISABLE Switch (Optional)**

This switch is a spring loaded, momentary contact switch. When activated, it will disable operation of the flange lube system for a 15 minute period. This may be useful when starting a train on a curve.

### **SNOW OPERATION Switch (Optional)**

This switch controls the operation of the Snow Brake feature. When the switch is in the On position, the brake system will maintain approximately 5 PSI of brake cylinder pressure to keep the wheels and brake shoes clear of ice and snow.

# CIRCUIT BREAKER PANEL



F52691

**Figure 2-47. Circuit Breaker Panel**

Several circuit breakers that control and protect the diesel engine and electrical control systems mount on this panel, located behind the Engine Control Panel as shown in Figure 2-47. A second circuit breaker panel is located in the Electrical Control Locker, however, none of these require normal access by operating personnel.

## WARNING

Operating Personnel are cautioned to **KEEP OUT** of the electrical control locker unless specifically directed by maintenance personnel. High voltage is present within the electrical control locker during, and sometimes after, locomotive operation.

The circuit breakers can be operated as switches, but also will trip open automatically if an electrical overload occurs. **Circuit breakers that have black-background / white-lettering nameplates must be On (lever Up) to operate the locomotive.**

To avoid causing EM2000 locomotive computer nuisance problems when operating circuit breakers:

### **At engine startup:**

1. Open the COMPUTER CONTROL breaker.
2. Close all other required breakers.
3. Close the COMPUTER CONTROL breaker.
4. Start the engine.

### **Before cycling or closing any breaker on this panel:**

1. Open the COMPUTER CONTROL breaker.
2. Cycle the breaker or close the open breaker.
3. Close the COMPUTER CONTROL breaker.

A brief description of devices on this panel follows.

### **GROUND RELAY CUTOFF Switch**

This toggle switch either arms the ground relay circuit (connects it to the locomotive power and control circuits), or disarms it.

**The switch normally is locked in the normal (lever Up) setting, arming the ground relay circuit, by a pin safety-wired to a bracket.**

Opening the switch (lever Down), cuts out the ground relay circuit for maintenance or troubleshooting purposes. This setting also prevents the locomotive from developing traction or dynamic braking effort.

### **RADIO / INT Breaker**

This circuit breaker protects the voice radio transceiver system - the radio transceiver in the workstation, the remote radio equipment on the conductor's side, and the intercom system (where used).

### **AUX. ELECTRONICS Breaker**

This breaker protects the control circuitry of auxiliary electronic equipment.

### **APC CONTROL Breaker**

This circuit breaker protects the control circuits for the Auxiliary Power Converter.

### **DYN BRAKE Breaker**

This circuit breaker protects the control circuits for the dynamic brake system.

## **LIGHTS Breaker**

This circuit breaker protects miscellaneous locomotive lighting circuits, such as:

- Locomotive Number Lights
- Engine Room Lights
- Platform Lights
- Dyn. Brake Hatch Compartment Lights
- Step Lights
- Locomotive Controller Indicating Light
- Engineer's and Helpers Reading Lights
- Engineer's and Helpers Floor Lights
- Cab Ceiling Lights
- Short Hood Lights
- Toilet Compartment Lights
- Stepwell Light

## **HDLTS/AUX Lights Breaker**

This circuit breaker protects the short hood and long hood headlight and ditch light circuits.

## **ENGINE CONTROL Breaker**

This circuit breaker protects the EMDEC (Electro-Motive Engine Control) power supply, which powers the EMDEC computers and the EMDEC locomotive interface circuit.

## **DITCH LIGHT Breaker**

Supplies power to and protects the Ditch Light circuit.

## **LOCAL CONTROL Breaker**

This circuit breaker establishes local (not trainlined) control with power from the locomotive battery or APC to operate heavy duty switchgear, magnet valves, contactors, blowers, and the locomotive computer input/output modules.

## **CONTROL Breaker**

This breaker protects and sets up fuel prime pump and control circuits for engine starting. It is supplied battery power through the battery knife switch before an engine start. Once the engine is running, the APC supplies power through this breaker to maintain operating control.

### **AIR BRAKE 1 Breaker**

This breaker protects the electrical/electronic air brake control system circuitry.

### **AIR BRAKE 2 Breaker**

This breaker protects the electrical/electronic air brake control system circuitry.

### **COMPUTER CONTROL Breaker**

This circuit breaker protects the EM2000 computer power supply, the computer itself and the sensors used by EM2000.

#### **CAUTION**

COMPUTER CONTROL and TURBO circuit breakers must both remain On (lever up) for up to 35 minutes after engine shutdown following load operation. This allows the turbo lube pump to continue running, to cool down turbo bearings.

### **CAB/DISPLAY Breaker**

This circuit breaker protects the FIRE system blower and the FIRE system operating power supply.

### **BRAKE TRANS. CONTROL Breaker**

Supplies power to, and protects, the motor/ (dynamic) brake switchgear operating motor circuit. If this breaker is open or tripped, changing the throttle/dynamic brake handle setting, from POWER to BRAKE, or vice-versa, does not immediately affect locomotive operation. Opening this breaker does not prevent continued operation in the same mode: if the breaker trips open (or is switched Open) during motoring operation, for example, motoring can continue (but transfer to dynamic brake cannot be set-up).

### **REV. CONTROL Breaker**

Supplies power to, and protects, the motor/ (dynamic) brake switchgear operating motor circuit. If this breaker is open or tripped, changing the reverser setting does not immediately affect locomotive operation.



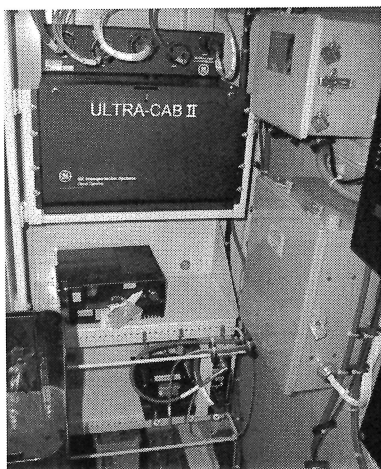
Opening this REV. CONTROL breaker does not prevent continued operation in the same mode: if the breaker trips open (or is switched Open) during forward operation, for example, forward operation can continue (but transfer to reverse operation cannot be set-up).

## **SHORT HOOD INNER VESTIBULE**

The short hood inner vestibule houses the toilet compartment and the cab electronics compartment.

### **CAB ELECTRONICS COMPARTMENT**

This compartment located on the right side of the locomotive inner vestibule at the bottom of the steps from the cab, houses the cab electronics rack. Various cab electronics equipment mounts on the rack inside the compartment, Figure 2-48.



F80001

**Figure 2-48. Cab Electronic Equipment**

### **TOILET COMPARTMENT**

This compartment, Figure 2-49, on the left side of the locomotive inner vestibule at the bottom of the steps from the cab, houses the Envirovac chemical toilet. The compartment is also equipped with a fold-up wash basin.



F51080

**Figure 2-49. Toilet Compartment**

## **ENGINE ROOM EQUIPMENT**

Engine cooling water, lube oil, and fuel oil pressures and temperatures are monitored by sensors at various locations on the engine and equipment rack. The monitored values are sent to the EM2000 locomotive computer and/or EMDEC computers. Some of these values are also available for display on the FIRE screens.

If any of the monitored values are outside the normal range, an EM2000 warning message displays on the FIRE system. An engine shutdown may occur if the measured value has reached a critical level.

### **ENGINE START ALARM HORN**

This device mounts in the engineroom. During the automatic diesel engine start cycle, it produces a loud warning sound - 1/2 second On - 1/2 second Off - for five seconds before the starter motors crank the engine.

### **WATER TEMPERATURE**

Temperature probes measure engine coolant temperature.

### **LUBE OIL TEMPERATURE AND PRESSURE**

Sensors monitor lube oil pressure across the filters and lube oil temperature into the diesel engine.

## **FUEL FILTER PRESSURE**

Sensors monitor pressures across the primary fuel filter assembly. If the pressure across the primary filter elements is too great, a bypass valve begins to open, bypassing the elements.

## **AIR PRESSURE TRANSDUCER**

A transducer monitors main reservoir air pressure level. The locomotive computer uses the transducer signal to control air compressor cut-in/ cut-out.

## **ENGINE OVERSPEED CONTROL**

Engine overspeed control is a function of the EMDEC system, which limits engine speed to a preset maximum by reducing engine fuel injection. EMDEC does not shut down the engine for overspeed unless another protected fault is detected.

## **MANUAL SHUTTER CONTROL VALVE**

The locomotive computer closes and opens air-operated engine cooling system radiator shutters by energizing and de-energizing a solenoid valve that pressurizes or exhausts air from the shutter operating cylinders.

The manual shutter control valve mounts at the rear of the equipment rack on the right (engineer's) side of the locomotive. For locomotive operation, set this valve in OPERATION to enable the locomotive computer to close the shutters by energizing the solenoid valve.

To open the shutters manually, set the shutter control valve in TEST, cutting off and exhausting the air supplied by the solenoid valve, which enables cylinder spring pressure to open the shutters.

## **MISCELLANEOUS EQUIPMENT**

### **EFCO SWITCHES, EXTERNAL**

A large red EFCO (emergency fuel cutoff) pushbutton mounts on the edge of the underframe on each side of the locomotive, near the fuel filler.

Pressing either EFCO pushbutton for approximately one second requests the locomotive computer to stop the diesel engine. Holding the button in for one second ensures that the locomotive computer recognizes the switch actuation. The pushbutton can be released after one second.

### **REMOTE FUEL GAUGES**

Fuel gauge display units are located on each side of the locomotive, near the fuel filter. The gauges requires power and air pressure in order to show the fuel quantity.

### **HANDBRAKE**

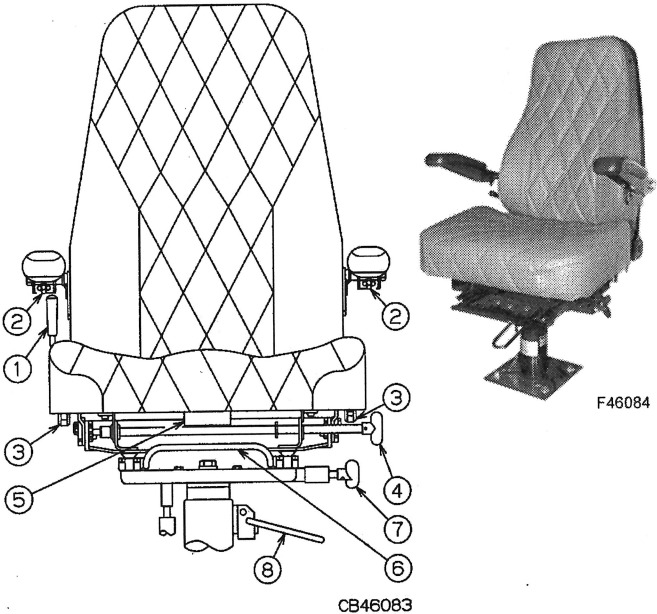
The wheel-type handbrake is at the right rear side of the locomotive long hood.

### **FIRE EXTINGUISHERS**

Two fire extinguishers are provided: one in the equipment vestibule in the short hood, the other next to the air compressor in the long hood.

# CAB SEATS

There are three seats in the cab. To adjust them, refer to the following directions which are keyed to Figure 2-50, page 2-58.



**Figure 2-50. Cab Seats**

**1. Lumbar Handle:**

- Turn clockwise to increase horizontal lumbar.
- Turn counterclockwise to decrease horizontal lumbar.

**2. Arm Adjustment Knob:**

- Turn clockwise to raise arm angle. Turn counterclockwise to lower arm angle.

**3. Seat Back Angle Adjustment Handwheel:**

- Turn clockwise to lower seat back.
- Turn counterclockwise to raise seat back.

4. **Cushion Lock Handle:**
  - Turn counter clockwise to unlock seat cushion. Adjust cushion per Item 5.
  - Turn clockwise to lock seat cushion.
5. **Cushion Adjustment Handle:**
  - Unlock cushion adjustment handle (Item 4), then push/ pull/ tilt seat cushion to desired position.
  - After adjusting seat cushion, lock adjustment handle (Item 4).
6. **Fore and Aft Lock Handle:**
  - To unlock, pull up on handle.
  - Move seat fore or aft while pulling up on handle.
  - Release handle to lock.
7. **Swivel Lock:**
  - To unlock, pull handle out.
  - Swivel seat to desired position.
  - Push handle in to lock.
8. **Seat Height Adjustment:**
  - Lift handle to unlock.
  - Allow seat to rise to desired height, or push seat down to desired height.
  - Release handle to lock.



---

---

# Section 3

## Operation

---

---

### Contents of Section

<u>Heading</u>	<u>Page</u>
<b>INTRODUCTION .....</b>	<b>3-3</b>
<b>PREPARATION FOR SERVICE .....</b>	<b>3-3</b>
Ground Inspection .....	3-3
Engineroom Inspection .....	3-3
Engine Inspection .....	3-4
Lead Locomotive Cab Inspection .....	3-5
Engine Start System .....	3-7
Engine Start Setup .....	3-8
Engine Start Procedure.....	3-9
Preparing Locomotives for Mutiple Unit Service .....	3-10
Starting Trailing Locomotive Diesel Engines .....	3-12
Setting Locomotive on Line .....	3-12
Precautions before Operating Locomotive .....	3-12
Handling Light Locomotive .....	3-13
Coupling Locomotives Together .....	3-13
Coupling Locomotive to Train .....	3-14
Pumping Up Air .....	3-14
Departure Tests .....	3-14
Penalty Brake Departure Test .....	3-16
Overspeed Departure Test .....	3-19
Alerter Test (Alerter Reset Test) .....	3-21
<b>STARTING TRAIN .....</b>	<b>3-22</b>
<b>THROWING REVERSER FOR EMERGENCY STOPPING (Plugging Traction Motors) .....</b>	<b>3-24</b>
<b>ACCELERATING TRAIN .....</b>	<b>3-24</b>
<b>WHEEL CONTROL .....</b>	<b>3-25</b>
<b>WHEEL CONTROL INDICATIONS .....</b>	<b>3-25</b>
<b>CUTTING OUT TRACTION MOTORS.....</b>	<b>3-30</b>



<b>MIXED GEAR RATIO OPERATION .....</b>	<b>3-30</b>
<b>LOCOMOTIVE SPEED LIMIT .....</b>	<b>3-30</b>
<b>AIR BRAKING WITH POWER.....</b>	<b>3-31</b>
Power at Stall.....	3-31
<b>OPERATING OVER RAIL CROSSING .....</b>	<b>3-31</b>
<b>RUNNING THROUGH WATER .....</b>	<b>3-32</b>
<b>DOUBLE HEADING .....</b>	<b>3-32</b>
<b>OPERATION IN HELPER SERVICE .....</b>	<b>3-32</b>
<b>DYNAMIC BRAKING .....</b>	<b>3-33</b>
Dynamic Braking with Locomotive	
Coupled to Older-Model Locomotives .....	3-35
Dynamic Brake Wheel Slip Control.....	3-35
<b>DYNAMIC BRAKING</b>	
<b>LOCOMOTIVES IN CONSIST .....</b>	<b>3-36</b>
<b>ISOLATING LOCOMOTIVE .....</b>	<b>3-36</b>
<b>CHANGING OPERATING ENDS .....</b>	<b>3-37</b>
On End Being Cut Out.....	3-37
On End Being Cut In.....	3-37
<b>FREEZING WEATHER PRECAUTIONS .....</b>	<b>3-38</b>
<b>DRAINING THE COOLING SYSTEM .....</b>	<b>3-38</b>
<b>TOWING LOCOMOTIVE DEAD IN TRAIN .....</b>	<b>3-39</b>
<b>TOWING UNIT DEAD IN CONSIST .....</b>	<b>3-40</b>
<b>LEAVING LOCOMOTIVE UNATTENDED .....</b>	<b>3-41</b>
<b>STOPPING ENGINES .....</b>	<b>3-42</b>
<b>SPEED CONTROL OPERATION .....</b>	<b>3-42</b>
<b>ALERTER SYSTEM OPERATION .....</b>	<b>3-45</b>
<b>DOWNLOADING</b>	
<b>FIRE GEN 2 EVENT RECORDER .....</b>	<b>3-47</b>
Event Recorder	
PCMCIA Download Procedure .....	3-48
Event Recorder	
Laptop Serial Download Procedure .....	3-49
Event Recorder Playback/Viewer Software .....	3-51

# INTRODUCTION

This section provides recommended procedures for setting up, preparing for service, and operating the locomotive. These procedures are brief, and do not include detailed equipment explanations. Refer to the Section 2 of this manual, the Running Maintenance Manual and/ or the Locomotive Service Manual for more specific descriptions of equipment locations and function. **Always comply with railroad rules and instructions regarding locomotive operation or inspection.**

To find information in this section, use the contents list that starts on page 3-1 or the Index at the end of the manual.

## PREPARATION FOR SERVICE

### Ground Inspection

Check the following, and correct as required:

- No fuel oil, lube oil, water, or air leaks.
- No parts are loose or dragging.
- Electrical control cables and air brake hose connections between locomotives, and to train, are properly installed.
- Angle cocks and shut-off valves are set properly.
- Truck air brake cylinders are cut in.
- Brake shoes are in satisfactory condition.
- Fuel supply is adequate.

### Engineroom Inspection

Inspect and operate engine room equipment by opening access doors along the sides of the locomotive long hood. Check for the following and correct as required:

- Check air compressor lube oil supply.
- Check all valves for proper settings.
- Check for leakage of fuel oil, lube oil, water, or air.

# Engine Inspection

Inspect the diesel engine before and after starting.

**Note:** Because this engine is EMDEC-equipped, it has no mechanical governor, overspeed trip mechanism, layshaft, low water reset pushbutton or crankcase reset pushbutton.

1. Make sure that engine top deck, air box, and oil pan inspection covers are in place and closed securely.
2. Check oil level dipstick on side of engine oil pan - it should be coated with oil.

**Note:** A properly filled lube oil system coats the dipstick above the FULL mark when the engine is stopped. For accuracy, recheck level when engine is idling at normal operating temperature.

## CAUTION

Engine must be prelubricated before it is started if lube oil filter elements have been changed, or if it has been shut down for more than 48 hours.

See Engine Maintenance Manual for directions.

3. Perform remaining engine checks - including the engine handhole (inspection) covers and lube oil levels in the filter tank and strainer housing. Maintain the strainer housing oil level up to the overflow outlet.
4. Check for fuel leaks at the EMDEC fuel system connections at both sides of the engine.
5. **Before engine top deck inspection, make sure locomotive is isolated (Isolation switch in STOP/ START/ ISOLATE) to prevent automatic engine speed-ups from spattering hot oil on inspection personnel.**

# Lead Locomotive Cab Inspection

## Electrical Set Up

Check and set equipment on the lead or control locomotive as follows -

## Engine Control Panel

- HEADLIGHT CONTROL switch -  
CONTROLLING W/ UNIT COUPLED AT LONG HOOD or  
CONTROLLING W/ UNIT COUPLED SHORT HOOD, as required.
- Light switches and FRESH AIR MAKE UP BLOWER switch -  
On as required.
- EFCO/STOP pushbutton switch -  
Released: not locked in ENGINE FUEL CUT OFF setting.  
See "ENGINE CONTROL PANEL" on page 2-44 for  
details.
- Isolation switch - START/STOP/ISOLATE.  
**Prevents automatic engine speedups beyond throttle  
2 RPM, which prevents hot oil from spattering  
personnel performing engine top deck inspection.**

## Circuit Breaker Panel

- Leave COMPUTER CONTROL breaker Open (Lever Down).
- All breakers with black background nameplates, including  
ENGINE CONTROL breaker - Closed (levers Up).
- Other circuit breakers - Closed (levers Up) as required.
- GROUND RELAY CUTOFF switch - Closed (lever Up).
- Close COMPUTER CONTROL breaker (Lever Up).

## Engineer's Control Stand

### Controller

- Throttle handle - IDLE
- Dynamic Brake handle - OFF
- Reverser (directional handle) - NEUTRAL (centered).

### Switch Panel

- CONTROL FUEL P. switch - On (slider Up).
- ENGINE RUN switch - On (slider Up).
- GEN. FIELD switch - Off (slider Down).
- DYN BRK CONT breaker - Closed (slide lever Up)
- Remaining devices - Set as required.

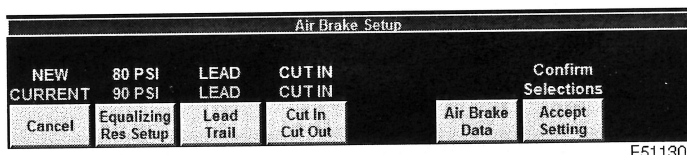
## Air Brake Set Up

**Note:** To set up the electronic air brake system or change the existing setup, the locomotive must be stopped or moving at less than 3.5 MPH.

If existing air brake system set up is LEAD-CUT IN at power up, the brake system computer will not take control until the automatic brake handle is set in SUP for ten seconds, then is returned to REL. (This is the same operation as resetting a penalty brake application.)

To set up the locomotive brake system for the lead position in a multiple consist or for single unit operation:

1. Set independent brake handle in FULL (full application).
2. Set automatic brake handle in REL (release).
3. Press *Air Brakes* key on FIRE Main Menu. (*Air Brake Setup* screen displays, Figure 3-1, next.)



F51130

**Figure 3-1. Air Brake Setup**

4. Press *Lead/Trail* key to select LEAD. (Cuts in independent brake valve.)

**Note:** *Lead/Trail* key is not available if locomotive speed is above 3.5 MPH or local reverser is thrown (not centered).

5. Press *Cut In/Cut Out* key to select CUT IN. (Cuts in automatic brake valve.)

**Note:** *Cut In/Cut Out* key is only available if LEAD has been selected.

6. *Freight Only* mode of operation is selected (passenger mode not provided).
7. To set up or change equalizing reservoir, press *Equalizing Res Setup* key. (Equalizing Reservoir Setup Menu displays.)

8. As required, press 80, 90, or 100 *psi* to select proper range, and adjust in single increments by pressing blank keys for hundreds, tens, units while watching the indicated *Equalizing Reservoir Setup Pressure*.
9. Press *Accept Setting* to enter selections. (Screen displays CONFIRM SELECTION BEFORE ACCEPTING.) Press *Accept* again to confirm selections.

## Engine Start System

The SD70M-2 engine starting system uses an air start motor. Pressing the ENGINE START button on the engine control panel starts the engine prime/start sequence. The prime/start sequence consists of the fuel prime cycle, the engine start alarm, then the engine start cycle (includes engine purge). Once the engine prime/start cycle begins, it continues until the engine starts, or a fault occurs, or an engine stop button is pressed.

**Note:** The turbo lube pump is activated at the beginning of the Fuel Prime/Start cycle.

The fuel prime cycle lasts for either 60 seconds or until EMDEC fuel sensors have detected sufficient fuel pressure for engine starting, whichever is shorter. Immediately after fuel priming ends, a warning sounds for 30 seconds in the engine room to alert personnel of the impending engine start. When the warning ends, engine cranking begins.

## Engine Start Setup

After the preceding inspections have been completed, the diesel engine may be started. Proceed as follows:

### CAUTION

**To avoid damaging the engine:**

**PREHEAT engine *before* starting, if:**

- Engine coolant water temperature is 50°F (10°C) or less.

**PRELUBE engine per Engine Maintenance Manual instructions *before* starting, if:**

- Engine is new in locomotive.
- Engine is being started for first time after overhaul.
- Engine has not run for more than 48 hours.

## Manually Purging The Engine

If the engine has been shutdown for more than 48 hours, the engine must be manually barred over to avoid an engine hydraulic lock when starting. To purge the engine:

1. Push in the EFCO/STOP pushbutton on the Engine Control panel and lock it into place. Open cylinder test valves and bar the engine over at least one revolution. Check for fluid leaks from the open test valves and notify maintenance personnel if any is observed.
2. Close cylinder test valves.
3. Unlock and release the EFCO/STOP pushbutton.
4. Open the COMPUTER CONTROL breaker (lever Down) in the electrical control cabinet.
5. Verify that all other breakers with black-background/white lettering nameplates on the circuit breaker panel are closed (levers Up).
6. Close the COMPUTER CONTROL breaker (lever Up).
7. Set isolation switch in START/STOP/ISOLATE.

# Engine Start Procedure

## WARNING

Before attempting to start the engine, make sure that all previous inspection/setup procedures have been done.

The EM2000 locomotive computer completely controls the automatic engine starting sequence:

1. To start the automatic sequence, press the START switch pushbutton on the engine control panel in the cab. **To abort the sequence, press an EFCO (emergency fuel cut off) button.**
2. The turbo lube pump runs, building turbo prelube pressure, the fuel pump runs, building fuel pressure, and the message  
FUEL PRIME CYCLE IN PROGRESS-  
PRESS ENGINE STOP TO SUSPEND  
displays. This continues for either one minute or until there is sufficient fuel pressure to run the engine.
3. The engine start alarm in the engine room sounds for thirty seconds to warn personnel. If fuel pressure does not build up within half a minute, the ENGINE FAILED TO PRIME-STARTING ENGINE, CHECK FUEL SYSTEM message displays for another half a minute and the engine is allowed to start.
4. When fuel pressure is within operating limits, message FUEL PRIME COMPLETE-STARTING ENGINE appears.
5. The starting motor pinion engages the engine flywheel. If the pinion does not fully engage, the locomotive computer waits for two minutes before retrying the sequence. If the starter still does not fully engage after the third attempt, the computer aborts the sequence, logs a fault, and displays a message.
6. When engine speed exceeds 150 RPM, the starting motor pinion disengages to complete the starting sequence. **If any system fails to respond properly, or if the engine fails to start, the locomotive computer aborts the sequence and logs a fault on the cab display** - for example:
  - If engine acceleration drops off, the message  
ENGINE START SEQUENCE ABORTED - LOW AIR PRESSURE.



If a starting system failure occurs, refer to Section 4 of this manual.

## After Engine Starts

Keep engine room doors closed after engine starts. Perform the normal fluid level checks with engine running at normal operating temperature.

### CAUTION

Do **not** advance throttle to increase engine speed above IDLE until oil pressure is confirmed.

Let engine coolant inlet temperature reach 120°F (49°C) at IDLE before applying load.

## Preparing Locomotives for Multiple Unit Service

Check the switches, circuit breakers, and controls located in the cab of a trailing locomotive for proper settings as described on the following pages.

### Engine Control Panel

- Headlight control switch -  
SINGLE UNIT OR INTERMEDIATE UNIT, OR  
CONTROLLED FROM ANOTHER UNIT COUPLED AT EITHER END.
- Light switches and FRESH AIR MAKE UP BLOWER switch --  
On as required.
- EFCO/STOP pushbutton switch -  
Released: not locked in ENGINE FUEL CUT OFF setting.  
See page 2-47 for details.
- Isolation switch - START/STOP/ISOLATE.  
Prevents automatic engine speedups beyond throttle 2 RPM, which prevents hot oil from spattering personnel performing engine top deck inspection.

### Circuit Breaker Panel

- Leave COMPUTER CONTROL breaker Open (Lever Down).
- All breakers with black background nameplates, including ENGINE CONTROL breaker - Closed (levers Up).
- Other circuit breakers - Closed (levers Up) as required.
- Close COMPUTER CONTROL breaker (Lever Up).
- GROUND RELAY CUTOUT switch - Closed (lever Up).

# Engineer's Control Stand

## Controller

- Throttle handle - IDLE
- Dynamic brake handle - OFF
- Reverser (directional handle) - centered, handle removed.

## Switch Panel

- CONTROL FUEL P. switch - Off (slider Down).
- ENGINE RUN switch - Off (slider Down).
- GEN. FIELD switch - Off (slider Down).
- DYN BRK CONT breaker - Open (slide lever Down)
- Remaining devices - Set as required.

## Air Brake Set Up

**Note:** To set up the electronic air brake system or change the existing setup, the locomotive must be stopped or moving at less than 3.5 MPH.

If existing air brake system set up is LEAD-CUT IN at power up, the brake system computer will not take control until the automatic brake handle is set in SUP for ten seconds, then is returned to REL. (This is the same operation as resetting a penalty brake application.)

To set up the locomotive brake system to trail in a multiple locomotive consist, set operator devices as follows:

1. Set independent brake handle - REL (Release).
2. Set automatic brake handle - HO (Handle Off).
3. Press *Air Brakes* key on FIRE Main Menu on engineer's display. (*Air Brake Setup* screen displays, Figure 3-2, next.)

Air Brake Setup						
NEW CURRENT	80 PSI 90 PSI	LEAD LEAD	CUT IN CUT IN	PASSENGER FREIGHT	Confirm Selections	
Cancel	Equalizing Res Setup	Lead Trail	Cut In Cut Out	Freight Passenger	Air Brake Data	Accept Setting

F51130

**Figure 3-2. Air Brake Setup**

4. Press LEAD/TRAIL key to select TRAIL. (Cuts out independent brake valve.)

**Note:** LEAD/TRAIL key is not available if locomotive speed is above 3.5 MPH or local reverser is thrown (not centered).

5. Press FREIGHT/PASSENGER key to select FREIGHT. (Sets up applicable apply/release rates. Available on some models).
6. Press ACCEPT SETTING to enter selections. (Screen displays CONFIRM SELECTION BEFORE ACCEPTING.) Press ACCEPT again to confirm selections.

## Starting Trailing Locomotive Diesel Engines

Start trailing locomotive engines in same manner as engine in lead unit - see "Engine Start System," page 3-7.

## Setting Locomotive on Line

### WARNING

Before putting a locomotive on line, verify that the throttle handle is set in IDLE and that the dynamic brake handle is set in OFF on every locomotive in consist.

To put the locomotive on line after the diesel engine is started, simply set the isolation switch in RUN.

**Note:** Locomotive computer often modifies diesel engine speed in response to operating conditions such as low main reservoir pressure. In such cases diesel engine speed may not be directly related to throttle handle setting.

## Precautions before Operating Locomotive

Do the following before operating the locomotive:

1. Make sure that main reservoir air pressure is normal.
2. Make sure that air brake system is set up correctly:  
LEAD/CUT-IN for a single or lead locomotive in consist, or  
TRAIL for a trailing locomotive in consist.
3. Make sure that air brakes apply and release properly by observing brake cylinders and brake rigging.
4. Release the hand brake and remove any blocking from under the wheels.

### **CAUTION**

To prevent undue engine wear and tear, make sure that engine coolant temperature is 120°F (49°C) or higher before fully loading engine. Also, if engine has been idling at ambient temperatures below 0°F (-18°C), increase to full loading gradually.

## **Handling Light Locomotive**

With engine running, air brake system set up LEAD/ CUT-IN, locomotive on-line, and preceding inspections and precautions completed, handle a light locomotive is as follows:

1. Set ENGINE RUN switch and GEN. FIELD switches On (levers Up).
2. Switch On headlights and other lights as needed.
3. Insert reverser handle and set it for the desired direction of travel, FORWARD or REVERSE.
4. Advance throttle.
5. Watch load meter on FIRE screen. Release air brakes in a few seconds when tractive effort develops.

## **Coupling Locomotives Together**

Use the following procedure to couple locomotives together for multiple locomotive operation:

1. Couple locomotives and stretch consist to ensure couplers are locked.
2. Install 27 conductor control cable between locomotives.
3. Couple walkway safety chains between locomotives.
4. Perform the ground, engine room, and engine inspections outlined in preceding pages.
5. Set cab controls for lead and trail operation as required, as outlined in preceding pages. Remove reversers from all trailing locomotive controllers to lock controls.
6. Connect air brake hoses between locomotives.
7. Open required air hose cutout cocks on each locomotive.

8. Using the lead unit's air brake controller, apply the brakes on the consist to determine if brakes apply on each locomotive. Release the automatic brake valve, then make sure the brakes on each locomotive are released.
9. Follow the same procedure to check independent brake application on each locomotive. Also, if necessary, release automatic service application by bailing with the independent brake handle. Inspect all brakes in the consist to verify brakes are released.

## **Coupling Locomotive to Train**

Couple locomotive to train, then:

1. Test to see that last locomotive and first car couplers are locked by stretching connection.
2. Connect air brake hoses.
3. Slowly open air valves on locomotive and train to cut in brakes.
4. Pump up air.

## **Pumping Up Air**

After cutting in the air brakes on the train, note the reaction of the main reservoir air pressure indicator on the FIRE display panel. If main reservoir pressure drops below 120 psi, the locomotive computer automatically speeds up the diesel engine, and the air compressor, to pump up air faster.

## **Departure Tests**

The FIRE system can automatically perform three departure tests: Penalty Brake, Overspeed and Alerter. To prepare for any departure test, follow these steps:

1. On engineer's FIRE panel, bring up FIRE Main Menu keys, Figure 3-3.

FIRE Main Menu Page 1					
Locomotive Data	Operator Controls	Speed Control	Length Counter	Air Brakes	More Choices
- OR - (See Step 2.)					
FIRE Main Menu Page 2					
EOT ID		Locomotive Monitor		Maint. Mode	More Choices

F43734

**Figure 3-3. FIRE Main Menu Pages 1 and 2**

2. On engineer's FIRE panel Main Menu, page 2, press *Maint. Mode* key. (It may be necessary to press *More Choices* key to get Main Menu, page 2 to appear.) *Maintenance Authorization* window, Figure 3-4, opens.

Maintenance Authorization					
Enter Authorization Code		0 2 3 2		Authorization Error. Please Try Again!	
October 7, 1997		<div style="display: flex; justify-content: space-around;"> <div style="border: 1px solid black; width: 40px; height: 30px;"></div> <div style="border: 1px solid black; width: 40px; height: 30px;"></div> <div style="border: 1px solid black; width: 40px; height: 30px;"></div> <div style="border: 1px solid black; width: 40px; height: 30px;"></div> </div>			
Cancel					Enter

F51136

**Figure 3-4. Maintenance Authorization**

3. Write Maintenance Authorization window date this way:  
**Month / Day / Year**,  
where:

**Month** = Month No. - 01 for Jan., 02 for Feb., etc.

**Day** = Day of Month - First day of mo. = 01, etc.

**Year** = Last Two No.'s. of Year - 2005 = 05, etc.

**Example:** August 10, 2005 = **08 / 10 / 05**

4. Convert **Month / Day / Year** date to Maintenance Authorization Code **A B C D**, as follows:
  - Total all individual numbers in **Month / Day / Year**.  
For date **08 / 10 / 05**, add 0 + 8 + 1 + 0 + 0 + 5.  
(Total equals 14.)  
Use last number of Total, **4** in this example, as number **A** in Maintenance Authorization Code.
  - Use last number of Year, **5** in this example, as number **B** in Maintenance Authorization Code.

- C. Use last number of Day, **0** in this example, as number **C** in Maintenance Authorization Code.
- D. Use first number of Day, **1** in this example, as number **D** in Maintenance Authorization Code.

**Example:** Authorization Code for **08/10/05** is **4 5 0 1**.

5. Enter Authorization Code from Step 4 on Maintenance Authorization window by pressing each of four blank keys to advance value in corresponding code digit.

If incorrect code is entered, message -

**Authorization Error. Please Try Again**

appears in orange lettering on right side of Maintenance Authorization window.

After correct code is entered on Maintenance Authorization window, Maintenance Menu, Figure 3-5, next, appears.

Maintenance Menu					
Departure Tests	Set Time/Date	Reset Odometer	Overspeed Setup	Diagnostic Menu	Exit

F43106

**Figure 3-5. Maintenance Menu**

6. Press *Departure Tests* key. Departure Tests keys, Figure 3-6, next, appear.

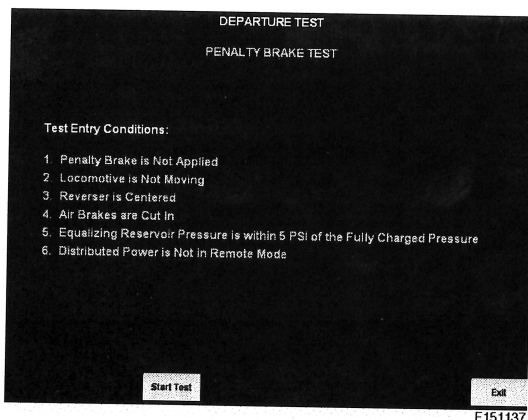
Departure Test			
Penalty Brake Test	Overspeed Test	Alerter Test	Exit

F43107

**Figure 3-6. Departure Test**

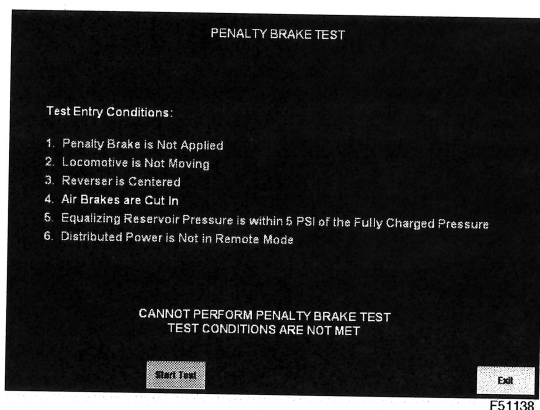
## Penalty Brake Departure Test

1. Bring up Departure Tests keys as directed by Departure Tests procedure, starting on page 3-14.
2. Press *Penalty Brake Test* key.  
Departure Test/ Penalty Brake Test Entry Conditions screen, Figure 3-7, page 3-17, appears.



**Figure 3-7. Departure Test - Penalty Brake Test**

3. Set up locomotive to meet Figure 3-7 Test Entry conditions. Those that are met display in green type. Any conditions that are not met display in yellow type, and an accompanying message also displays in yellow type, as Figure 3-8 shows. (Bold type in Figure 3-8 symbolizes yellow text.)

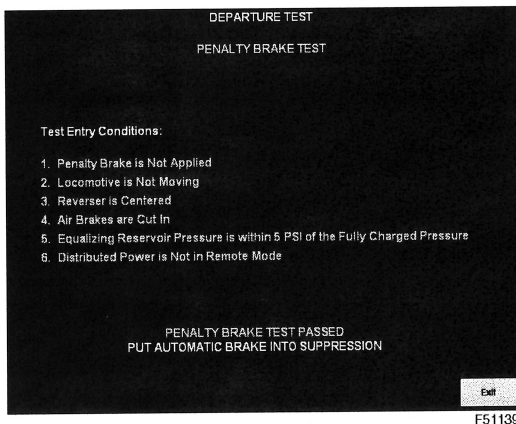


**Figure 3-8. Penalty Brake Test - Test Conditions Are Not Met**

While Test Entry Conditions screen displays, entry condition status is continuously updated.



4. When all test entry conditions are met, press the *Start Test* key. While the test is in progress, the screen remains the same as Figure 3-8, except that the *Start Test* key disappears and the message - **CANNOT PERFORM PENALTY BRAKE TEST...** is replaced with the message **PENALTY BRAKE TEST IN PROGRESS**.  
If anything causes the test to abort, the screen reverts to the test entry conditions screen, Figure 3-7, page 3-17.
5. When the penalty brake condition is successfully reached, the yellow **PENALTY BRAKE TEST IN PROGRESS** message is replaced with the green **PENALTY BRAKE TEST PASSED** message, and the yellow instruction message **PUT AUTOMATIC BRAKE INTO SUPPRESSION** displays below that, as shown in Figure 3-9.



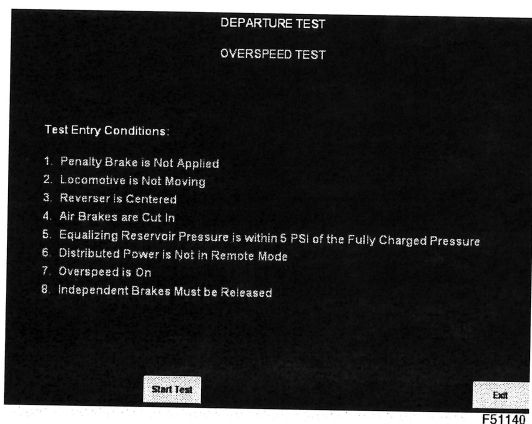
**Figure 3-9. Penalty Brake Test Passed**

If the test fails, the screen is the same as Figure 3-9, except the green **PENALTY BRAKE TEST PASSED** message is replaced with the red **PENALTY BRAKE TEST FAILED** message.

6. When test has completed (**PASSED** or **FAILED**), press the *Exit* key. The screen returns to the *Departure Test* menu, Figure 3-6, page 3-16.

## Overspeed Departure Test

1. Bring up Departure Tests keys as directed by Departure Tests procedure, starting on page 3-14.
2. Press *Overspeed Test* key.  
Departure Test/ Overspeed Brake Test Entry Conditions screen, Figure 3-10, page 3-19, appears.
3. Set up locomotive to meet Figure 3-10 Test Entry conditions. Those that are met display in green type. Any conditions that are not met display in yellow type, and an accompanying message also displays in yellow type, as Figure 3-11, page 3-20, shows. (Bold type in Figure 3-11 indicates yellow type.)  
While Test Entry Conditions screen displays, entry condition status is continuously updated.

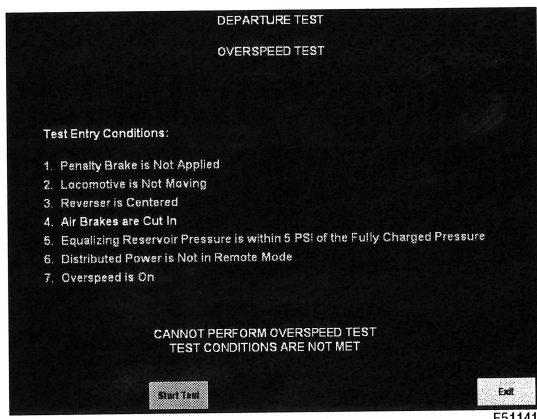


**Figure 3-10. Departure Test - Overspeed Test**

4. When all test entry conditions are met, press the *Start Test* key. While the test is in progress, the screen remains the same as Figure 3-11, except that the *Start Test* key disappears and the **CANNOT PERFORM OVERSPEED TEST...** message is replaced with the message **OVERSPEED TEST IN PROGRESS**.

As the test progresses the locomotive speed indicated on the engineer's FIRE panel increases.

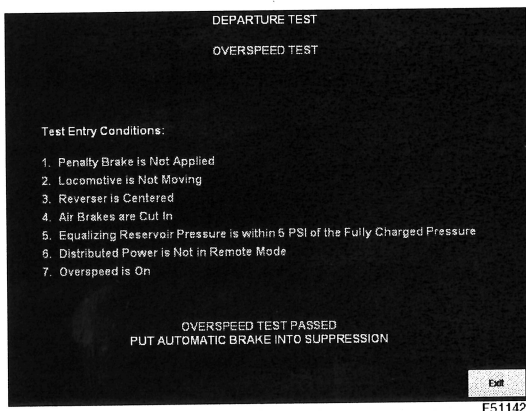
If anything causes the test to abort, the screen reverts to the test entry conditions screen, Figure 3-11.



**Figure 3-11. Overspeed Test - Overspeed Test Conditions Are Not Met**

5. When the overspeed condition is successfully reached, the yellow **OVERSPEED TEST IN PROGRESS** message is replaced with the green **OVERSPEED TEST PASSED** message, followed by the yellow instruction message **PUT AUTOMATIC BRAKE INTO SUPPRESSION**, as shown in Figure 3-12, below.

If the test fails, the screen is the same as Figure 3-12, except the green **OVERSPEED TEST PASSED** message is replaced with the red **OVERSPEED TEST FAILED** message.



**Figure 3-12. Overspeed Test Passed**

6. When test has completed (**OVERSPEED TEST PASSED** or **FAILED**), press the *Exit* key. The screen returns to the *Departure Test* menu, Figure 3-6, page 3-16.

## **Alerter Test (Alerter Reset Test)**

**Note:** This test verifies that actuating various operator functions resets the alerter system. It does not verify alerter system timing, suppression, or penalty brake initiation.

1. Bring up Departure Tests keys as directed by Departure Tests procedure, starting on page 3-14.
2. Press *Alerter Test* key.

Alerter test entry screen, Figure 3-13, next, appears. (Devices may be listed in a different order than shown on Figure 3-13.)

<b>DEPARTURE TEST</b>		
<b>Alerter Functions (Actuate for Alerter Response)</b>		
Throttle	Dynamic Brake	Reverser
Bell	Automatic Brake	Independent Brake
Horn	Safety Reset	
<input type="button" value="Start Test"/>		<input type="button" value="Exit"/>

F43913

**Figure 3-13. Departure Test - Alerter Test**

3. Press *Start Test* key. *Start Test* key and *End Test* key appears. (Pressing *Exit* key returns screen to Departure Test menu, Figure 3-6, page 3-16.)
4. One at a time, operate each device named on alerter test entry screen, Figure 3-13 - *Throttle*, *Bell*, *Horn*, etc.  
**Note:** Operating any listed device resets the alerter. As alerter system recognizes each device actuation, it sounds a double beep, and displays a yellow arrow to the left of the device name, as shown on Figure 3-14, page 3-22.

5. When all devices on the list have been checked, either press *End Test* key, returning screen to Departure Test menu, Figure 3-6, page 3-16, or press *Exit* key, returning screen to Maintenance Menu, Figure 3-5, page 3-16.

DEPARTURE TEST		
Alerter Functions (Actuate for Alerter Response)		
➔ Throttle	Dynamic Brake	Reverser
➔ Bell	Automatic Brake	Independent Brake
Horn	Safety Reset	
<input type="button" value="End Test"/>		<input type="button" value="Exit"/>

F43115

**Figure 3-14. Departure Test - Alerter End Test**

## STARTING TRAIN

Selecting a method for starting a train depends on many factors, such as train type, weight, length, amount of slack, track condition, grade, and weather conditions. Since these factors are variable, specific train starting instructions cannot be provided - it is up to the engineer to use good judgment in properly applying locomotive power to suit existing conditions. However, certain general considerations are provided in the following paragraphs.

Proper throttle handling is important when starting trains - it has a direct bearing on the power being applied. As the throttle is advanced, power increases almost immediately; how much power develops depends on throttle setting. It is advisable to advance the throttle one notch at a time when starting the train. Start in as low a throttle setting as possible to keep locomotive speed low until all slack has been taken up (train completely stretched). Sometimes it is advisable to reduce the throttle a notch or two when the locomotive begins to move in order to prevent stretching slack too quickly or to avoid slipping. When ready to start, use the following general procedure:

1. Set isolation switch in RUN.
2. Set reverser handle in desired direction, FORWARD or REVERSE.
3. Set ENGINE RUN and GEN. FIELD switches On. Release both automatic and independent air brakes.
4. Advance throttle handle:
  - A. First, to notch 1 - loading increases to a low level, as shown on the tractive effort indicator on the FIRE screen. If total train weight is small or the train is not on an ascending grade, the train may begin moving in throttle 1.  
**Note:** It is not necessary to manipulate the throttle handle between notch 1 and IDLE during starting.
  - B. Then, to notch 2, 3, or higher - until locomotive moves. After train is stretched, advance throttle as desired.

**Note:** When locomotive is operating at full throttle, the wheel slip control system corrects successive minor slips so quickly that the wheel slip indicator seldom lights. Such corrections often cause the tractive effort meter to indicate lower than full power tractive effort. Do not misinterpret the reduced tractive effort as a fault - the wheel slip control system is maintaining as much tractive effort as permitted by the existing adhesion conditions.

## **THROWING REVERSER FOR EMERGENCY STOPPING (Plugging Traction Motors)**

On locomotives with DC traction motors, the traction motors are plugged by setting the throttle handle in IDLE, throwing the reverser handle to oppose the direction of travel, then advancing the throttle handle, which causes the traction motors to suddenly apply tremendous opposite direction tractive effort. At very low speeds, the locomotive stops quickly, but at higher speeds, plugging can trigger traction motor flashovers, causing serious equipment damage. Plug mode is provided to .8 MPH.

## **ACCELERATING TRAIN**

After the train has started moving, advance the throttle as rapidly as desired to accelerate the train consistent with Railway train handling rules.

The load meter provides a good guide for throttle handling when accelerating a train. The meter pointer moves rightward (greater traction motor current) as the throttle advances. Then train speed increases, and the meter pointer begins moving leftward (traction motor current decreasing). At that point, the throttle may again be advanced for optimum acceleration. For maximum smooth acceleration, advance the throttle one notch each time the meter pointer begins to move to the left, until locomotive produces full power in throttle 8.

# WHEEL CONTROL

The locomotive computer wheel control function consists of two sub-functions, controlled creep and slip control. Each is directed at a different wheel operating mode.

- **CONTROLLED CREEP** enables the locomotive wheels to drive slightly faster than ground speed (i.e. it allows "wheel creep") when more traction is gained by doing so, such as when rail conditions are adverse. This function operates whenever needed in motoring and dynamic braking. The radar transceiver provides ground speed to the locomotive computer as a basis for wheel creep control.

**Note:** Vibration and/or squealing noise may accompany wheel creep operation, which usually occurs when rail conditions are not ideal.

- **WHEEL SLIP CONTROL** operates if a wheel creep control failure occurs (radar failure, for example) or if rail conditions are too poor for continuously successful wheel creep control.

The locomotive computer selects the appropriate type of wheel control to suit operating conditions. It also applies sand if rail conditions are severe.

The wheel control function may cause the WHEEL SLIP indicator on the FIRE screen to flash or light steadily.

## WARNING

**Very dangerous fault conditions can cause the WHEEL SLIP indicator to flash persistently or light steadily. Read the following information.**

## WHEEL CONTROL INDICATIONS

Four conditions on this locomotive ("local" conditions) can cause the WHEEL SLIP indicator on the FIRE screen to light.

**Note: Any WHEEL SLIP indicator on a trainlined locomotive also lights this locomotive's FIRE screen WHEEL SLIP indicator, and displays a message indicating that another locomotive is originating the WHEEL SLIP indication.**

One local condition, LOCKED WHEEL, is a possibly dangerous fault requiring immediate crew action. The other three, WHEEL SLIP, WHEEL SLIDE, and WHEEL OVERSPEED, do not require immediate crew action. The four conditions are:



# **1. Locked Wheel Condition:**

**Note:** Refer to, and follow railroad regulations concerning Locked Wheel faults.

Locomotive computer immediately lights WHEEL SLIP indicator and drops load when the control system detects a locked wheel. After 10 second delay, (20 if air brakes are applied), locomotive computer sounds the alarm bell, continues WHEEL SLIP light, and displays the following message:

#n LOCKED WHEEL - STOP TRAIN AND THEN  
CHECK IF THE WHEELS TURN FREELY.

Fault indications above continue until engineer resets fault on FIRE display panel Locomotive Data window.

**See WARNING, next.**

## **WARNING**

**Locked wheels on moving locomotives are very dangerous. If locked wheel is indicated, perform the following procedure.**

## **Locked Powered Wheel/ Slipped Pinion Procedure**

- A. Stop the train.**
- B. Find the locomotive indicating LOCKED POWERED WHEEL or SLIPPED PINION.**
- C. Slowly roll locomotive with indication past observer watching for sliding wheels and “birdnested” traction motors, and listening for unusual noises from traction motors and gearcases.**

**Are there sliding wheels, “birdnested” traction motors, or unusual noises from traction motors or gearcases?**

**Yes - Go to Step D; No - Go to Step E.**

- D. Take appropriate action specified by applicable railroad rules and regulations concerning LOCKED POWERED WHEEL and/or SLIPPED PINION**

### **WARNING**

**Do not, under any circumstance, tow a locomotive having sliding or locked wheels, or move such a locomotive in consist.**

- E. Reset fault by pressing RESET key on EM2000 screen displaying LOCKED POWERED WHEEL and/or SLIPPED PINION fault message.**

## Locked Wheel Detection Disabling/Enabling

If false locked wheel detection has been diagnosed and Railroad rules permit, **disable locked wheel detection** on the diagnosed axle to enable continued operation to a maintenance point, as follows:

1. Bring up Locomotive Data Main Menu on FIRE display.
2. Select "Lock Wheel Detect." (Locked Wheel Detection Status screen appears, describing the locked wheel detection status for each locomotive axle - ENABLED or DISABLED, and providing an ENABLE or DISABLE designation for a pushbutton key, depending on which axle is selected by the cursor.)
3. Using the FIRE display panel keys, select the axle that was determined to have bad locked wheel detection. (Screen displays ENABLED status for that axle, and pushbutton key is designated DISABLE.
4. Press DISABLE key. (Axle status changes to DISABLED, and DISABLE key designation changes to ENABLE.)
5. Press EXIT key. (Locomotive Data Main Menu appears.)
6. Press EXIT key again. DISABLE Main Menu disappears and following message appears for as long as detection is disabled on the axle:  
#n MOTOR SPEED SENSOR DISABLED FOR  
LOCKED WHEEL DETECTION.

### To re-enable locked wheel detection on an axle:

1. Bring up Locomotive Data Main Menu on FIRE display panel.
2. Select "Lock Wheel Detect." (Locked Wheel Detection Status screen appears.)
3. Using the display panel keys, select the axle that is to have locked wheel detection re-enabled.
4. Press ENABLE key. (Axle status changes to ENABLED, and key designation changes to DISABLE.)
5. Press EXIT key. (Locomotive Data Main Menu appears.)
6. Press EXIT key again. (Locomotive Data Main Menu disappears, and #n MOTOR- - - - DETECTION message no longer displays for that axle).

### 2. Wheel Slip Condition:

While starting a train *when rail conditions are exceptionally poor*, an *occasional* WHEEL SLIP indicator flash indicates normal wheelslip control. Automatic sanding may also occur. Do not reduce throttle setting unless severe lurching threatens to break train.

**Note:** When rail conditions are poor and the locomotive is operating in power faster than 1.5 MPH (2.4 km/h), *occasional, irregular* WHEEL SLIP indicator *flashing* may indicate wheel creep control failure. Operation may continue, but report condition to authorized maintenance personnel.

### 3. Wheel Slide Condition:

While operating in dynamic brake, *intermittent* WHEEL SLIP indicator *flashing* indicates normal wheelslide control. Automatic sanding may also occur.

#### 4. **Wheel Overspeed Condition:**

The WHEEL SLIP indicator flashes On and Off to indicate wheel (and traction motor) overspeed, caused by excessive track speed or simultaneously slipping all locomotive wheels. In either case, the system automatically corrects by reducing traction alternator output.

## **CUTTING OUT TRACTION MOTORS**

To cut out a traction motor and observe the following:

### **WARNING**

Before operating a locomotive that has a cut-out traction motor, roll it past an observer. The observer should make sure that the wheels driven by the cut-out motor rotate freely, and that the cut-out motor (including gear case) does not make any unusual noise and/or is not "birdnested."

## **MIXED GEAR RATIO OPERATION**

### **CAUTION**

If locomotives in the consist have different gear ratios, do not operate the consist faster than the limit for the locomotive with the slowest speed limit. Also, do not operate the consist continuously slower than the minimum continuous speed (maximum motor current) rating for any locomotive in the consist.

For related information about this locomotive, see "Locomotive Speed Limitation," page 1-4.

## **LOCOMOTIVE SPEED LIMIT**

The maximum speed at which the locomotive can be operated without endangering the traction motors is determined by traction motor-to-axle gearing and traction motor design. The maximum speed for this locomotive, as shipped from EMD, is 70 MPH.

As locomotive wheels wear to smaller diameters, the maximum speed drops.

## AIR BRAKING WITH POWER

Air brake equipment handling methods are left to the discretion of the railroad. However, when braking with power, remember that for any given throttle setting, draw bar pull rapidly rises as train speed drops. It can become great enough to part the train unless the throttle setting is reduced as the train slows.

Because traction motor current determines draw bar pull, the operator can maintain a constant pull on the train during slowdown by maintaining steady traction motor current. Do so by reducing the throttle one notch whenever load meter indicated current starts to increase (pointer moves to right). EMD recommends that the independent brakes be kept fully released during dynamic braking. The throttle must be set in IDLE before the locomotive comes to a stop.

### **Power at Stall**

Do not hold the train at standstill on a grade or with air brakes applied and throttle open in power. Doing so can seriously damage the traction motors.

## OPERATING OVER RAIL CROSSING

When operating the locomotive at speeds exceeding 25 MPH, reduce power to throttle 4 at least eight seconds before reaching a rail crossing.

If operating at throttle 4 or lower, or running at speeds less than 25 MPH, reduce the throttle to the next lower notch at least eight seconds before reaching a rail crossing.

Advance the throttle only after all locomotives in consist have passed over a crossing. This ensures that traction motor and generator voltage levels decay to a safe level before rail crossing mechanical shock is transmitted to the motor brushes.

# RUNNING THROUGH WATER

## CAUTION

**Do not**, under any circumstances, operate the locomotive through water deep enough to touch the bottom of the traction motors. Water any deeper than 3" (760 cm) above the rails is likely to cause traction motor damage. When passing through any water on the rails, exercise every precaution, and never exceed 2 to 3 MPH.

## DOUBLE HEADING

In double heading service, an extra locomotive is temporarily coupled to the lead end of the lead locomotive, air brake pipes are connected between them, but MU electrical jumper cables are not. There is an engineer in each locomotive.

Before double heading behind another locomotive, make a full service brake pipe reduction with the automatic brake valve, then set up the air brake system in LEAD, CUT-OUT, as described on page 3-6, except select CUT-OUT instead of CUT-IN.

Throttle operation is normal, but the air brakes are controlled from the lead locomotive. An emergency air brake application may be made however, from the automatic brake valve of the second unit. Also, the automatic brake on this locomotive may be released bailing off the independent brake handle while both independent and automatic brake handles are set in release.

When double heading operation is completed, change the air brake system setup back to LEAD, CUT-IN.

## OPERATION IN HELPER SERVICE

**Note:** Helper air brake system set-up is the same as for Double Heading, above.

For operation, refer to Railroad operating rules and instructions.

# DYNAMIC BRAKING

## WARNING

Dynamic brake system is disconnected when operating locomotive with a traction motor cut out.

Dynamic braking can be extremely useful for reducing train speed in many phases of locomotive operation. It is particularly valuable while descending grades. **Dynamic braking retards locomotive wheel speed, but does not apply braking on the rest of the train.**

Maximum dynamic braking effort is obtained at a specific speed, depending on locomotive gear ratio. This locomotive is equipped with 43" wheels and an 83:18 gear ratio, and obtains maximum braking effort at about 22 MPH.

As locomotive speed rises above 22 MPH, brake effort gradually declines. Therefore it is important that dynamic braking be started before train speed becomes excessive. While in dynamic braking, do not allow train speed to creep upward by careless dynamic brake handling.

**Note:** This locomotive has grid current controlled, extended range dynamic braking.

Dynamic brake effort holds approximately near the 22 MPH peak as locomotive speed slows from 22 MPH to approximately 9.5 MPH, where it starts dropping off sharply in proportion to speed.

To operate dynamic brakes, proceed as follows:

1. Reverser must be set in desired direction of travel.
2. Return throttle handle to IDLE, and wait for ten seconds before proceeding.

## WARNING

Allow ten second delay to completed before setting dynamic brake handle in SET UP.

It is possible for a sudden dynamic braking effort surge to occur if the dynamic brake handle is already advanced when the delay times out. Braking delay occurs automatically.

Do not misinterpret the ten second delay as a dynamic brake system failure.



3. Set dynamic brake handle in SET UP. This establishes dynamic braking circuits. Minimal braking effort occurs (indicated on load meter).
4. After slack is bunched, advance dynamic brake handle past SET UP to initiate dynamic braking. As the handle advances out of SET UP, engine speed automatically increases.
5. As dynamic brake handle setting advances from 1 toward 8, braking effort (as well as engine speed) increases on this locomotive, which has grid current controlled dynamic brakes.

Older-model locomotives may not have the same dynamic brake system as this locomotive, and, therefore, may not react in the same manner when dynamic brake handle is moved.

Because dynamic brake current regulation is automatic, the BRAKE WARN indicator should rarely light. However, if it *does*, stop advancing dynamic brake handle until light goes out.

If BRAKE WARN light fails to switch Off after several seconds, move dynamic brake handle back slowly until light switches Off. Then advance handle to increase braking effort.

### CAUTION

**The BRAKE WARN indication is trainlined: a warning appears in the lead unit if any unit in the consist generates excessive dynamic braking current. Thus, regardless of load meter reading or dynamic brake handle setting (which may be less than maximum), do not allow the BRAKE WARN indicator to remain On for any longer than two or three seconds before taking steps to reduce braking effort.**

If BRAKE WARN indications repeat, take lead locomotive out of dynamic braking, and set DYNAMIC BRAKE switch (on engine control panel) in CUTOUT position on affected locomotive. Locomotive consist will then operate normally under power and during dynamic braking, but total braking effort will be reduced.

6. When necessary, automatic air brakes may be used in conjunction with the dynamic brake. However, whenever dynamic brake is in use, keep independent (air) brake fully released to prevent wheel slides.

### **CAUTION**

Any emergency or safety control air brake application disconnects dynamic braking.

## **Dynamic Braking with Locomotive Coupled to Older-Model Locomotives**

The locomotive can be operated in dynamic braking when coupled to older locomotives that are not equipped with brake current limiting regulation. If all locomotives have the same ratio, the locomotive having the lowest maximum brake current rating should be the lead locomotive of the consist. The operator can then operate and control braking effort up to the limit of the locomotive having the lowest brake current rating, without overloading the dynamic brake system of a trailing locomotive.

The locomotive consist must be operated so as not to exceed the braking current of the locomotive having the lowest maximum brake current rating.

Locomotives with dynamic brake current limiting regulation can be operated in multiple with other locomotives in dynamic braking regardless of the gear ratio, wheel size, or difference in the maximum brake current ratings.

## **Dynamic Brake Wheel Slip Control**

In dynamic braking, wheel slip is called wheel slide. It consists of one wheelset decelerating more quickly than the others, and sliding on the rail.

Wheel slides are somewhat self-correcting because of the dynamic brake grids/traction motors circuit design. However, EM2000 wheel slip control routine operates during dynamic braking as well as during power operation. This protection provides extremely stable dynamic brake operation.

In dynamic braking, when EM2000 detects that one set of wheels is rotating more slowly than the others, it acts to reduce braking effort and to apply sand, which corrects the wheelslide.

After the wheelset resumes normal rotation, the braking effort of the traction motors returns to normal. Automatic sanding continues for a short period after wheel slip is corrected.

**Note:** Manual sanding is available at any speed in dynamic braking.

## **DYNAMIC BRAKING LOCOMOTIVES IN CONSIST**

The dynamic brake handle operates the dynamic brake rheostat. The rheostat voltage level also is applied to a trainline wire. That voltage level controls dynamic braking on all locomotives in consist equipped for dynamic braking. The total braking effort of a multi-unit consist can become quite high. Follow railroad rules regarding multiple unit dynamic braking.

## **ISOLATING LOCOMOTIVE**

Observe the following when isolating the locomotive:

1. If the locomotive is operating in power in a multiple unit consist, it may be isolated at any time, but be careful about when it is done, and make sure it really is necessary.
2. End power and dynamic braking operation before attempting to isolate the locomotive by first setting the lead locomotive throttle in IDLE and dynamic brake handle in OFF.
3. Set isolation switch in START/ STOP/ ISOLATE to prevent power and dynamic braking on that unit. When power or dynamic braking is resumed by lead locomotive, the locomotives in consist that are not isolated will function normally.

# CHANGING OPERATING ENDS

If a consist includes two or more locomotives with operating controls, the following procedure is recommended to change control from one operating end to other, provided that the locomotives are equipped with 26L brakes.

## On End Being Cut Out

1. Set independent brake handle in Full (full application).
2. Set automatic brake valve handle in a service position to make a 20 psi reduction.
3. Allow the brake pipe exhaust to stop.
4. Set up the brake system for *TRAIL*.
5. Set the independent brake handle in REL (Release).
6. Set automatic brake valve handle in HO (Handle Off).
7. With throttle handle in IDLE and dynamic brake handle in OFF, set the reverser in NEUTRAL, then remove it to lock the controls.
8. Set all switches Off. Make sure that GENERATOR FIELD switch and ENGINE RUN switch are Off (sliders Down).
9. At the engine control panel, set remote headlight control switch for trailing unit operation. Set other switches On as needed.
10. Set all black panel area circuit breakers On (levers Up).
11. After completing the preceding steps, move to the cab of the new lead unit.

## On End Being Cut In

1. At the switch panel make sure that the GEN. FIELD switch is Off (slider Down).
2. Insert reverser and leave in NEUTRAL position.
3. Set automatic brake handle in SUP (Suppression) to clear any power-up penalty.
4. Set independent brake to FULL (Full Application).

5. To avoid an emergency brake application, set air brake system to LEAD - CUT OUT.
  - Allow Equalizing Reservoir to come up to 90 psi with automatic brake handle in REL (Release).
  - Return to Air Brake Set Up FIRE screen and change configuration to LEAD - CUT IN.
6. Set all black nameplate circuit breakers On (up).
7. At the engine control panel, set remote headlight control switch in proper position and set other switches On as needed.
8. Set the ENGINE RUN, CONTROL FUEL P. (fuel pump), and GENERATOR FIELD switches On (sliders Up) and other switches On as needed.

## **FREEZING WEATHER PRECAUTIONS**

When the engine is running, it keeps the cooling system warm enough to prevent freezing. However, if the engine stops, and freezing temperatures are possible, protect the cooling system by somehow keeping the coolant warm, or by completely draining it.

Most SD70M-2 locomotives are equipped with a thermo-mechanical automatic drain valve. Observe your railroad instructions for cooling system draining.

### **WARNING**

Failure to protect the cooling system against freezing may result in severe locomotive damage.

## **DRAINING THE COOLING SYSTEM**

When necessary to drain the cooling system, open the engine coolant drain valve located at the pit between the engine and accessory rack. Opening this valve drains the engine, coolant tank, air compressor, and associated piping.

### **CAUTION**

If engine is hot, allow it to cool down before refilling it with coolant.

# TOWING LOCOMOTIVE DEAD IN TRAIN

The air brake system computer requires battery power to operate. Therefore, if the locomotive is shipping with the engine dead, open the AIR BRAKE circuit breaker to protect the locomotive batteries. With the AIR BRAKE breaker open, the pneumatic backup system controls air brake system operation.

**Note:** The air brake system computer connects to the locomotive batteries through the battery knife switch. Therefore opening the battery knife switch also isolates the brake system computer from the locomotive batteries.

When a locomotive equipped with electronic air brakes is to be towed in a train, set control and air brake equipment as follows:

1. Set automatic brake handle in release (REL).
2. Set independent brake handle in release (REL).

If the locomotive is to be shipped with the engine running, then set up the air brake system for LEAD/CUT-OUT and make sure that the AIR BRAKE circuit breaker is closed (lever Up).

If the locomotive is being shipped with the engine dead, open the AIR BRAKE circuit breaker and silence the alarm by pressing the *Operator Controls* key on the FIRE Main Menu, then pressing the *Alarm Bell Silence* key on the operator controls menu. Proceed as follows:

1. Close the conductor's emergency brake valve.
2. Isolate all safety control devices if possible.
3. Open all brake cylinder cut out cocks.
4. Open all end connection cut out cocks.
5. Open the dead engine cut out cock. (It mounts in the cab subbase, on the engineer's side.)
6. Open main reservoir drain valves to drain main reservoir pressure to approximately 20 psi.
7. Close main reservoir drain valves.

8. Connect locomotive brake pipe to train brake line and charge brake system. Main Reservoir (#2 MR) will charge to a maximum of 25 psi.

From controlling locomotive -

- Test brakes by making a 20 psi brake pipe reduction - make sure that brake cylinders apply.
- Increase brake pipe pressure to release brakes.

**Note:** If engine is running, locomotive (and brake) set-up must be for a *Trailing* unit in consist.

**If engine is to remain idling**, set switches as follows:

- A. Isolation Switch - START/STOP/ISOLATE.
- B. Battery switch & GROUND RELAY CUTOFF switch - Closed (levers Up).
- C. GENERATOR FIELD circuit breaker - Off (lever Down).
- D. All black panel area circuit breakers - On (levers Up).
- E. CONTROL FUEL P. switch - On (lever Up).
- F. FUEL PUMP circuit breaker On (lever Up).
- G. Throttle handle - IDLE.
- H. Dynamic brake handle - OFF.
  - I. Directional handle (Reverser) - Removed (locks controls)

## TOWING UNIT DEAD IN CONSIST

If a locomotive is to be towed Dead In Consist, set control equipment as follows:

1. If locomotive is to be towed with all MU hoses connected to the consist, then normal set up of the brake system for TRAIL operation is required.
2. If the locomotive is to ship without main reservoir equalizing, independent application and release, and actuating MU hoses connected to the consist, then set up the locomotive as described in Towing Locomotive Dead In Train.

**See WARNING, next.**

## **WARNING**

When towing a locomotive dead in consist

- The dead unit must be connected for MU operation.

3. Battery switch closed.
4. All breakers Off (levers Down) except COMPUTER CONTROL, and CONTROL, which all must be On (levers up). See previous WARNING.
5. All control switches Off.
6. Throttle handle in IDLE and Dynamic Brake handle in OFF. Remove reverser from controller to lock controls.
7. MU jumper cables must be installed on dead unit.

## **LEAVING LOCOMOTIVE UNATTENDED**

If it is necessary to leave the locomotive unattended while the engine is running, use the following procedure:

1. Observe all railroad safety precautions.
2. Isolate the unit.
3. Set ENGINE RUN and GENERATOR FIELD switches Off (sliders Down).
4. Set throttle/dynamic brake handle in IDLE. Remove reverser (directional handle) from controller to lock controls.
5. Set air brakes.
6. Set parking brake.



# STOPPING ENGINES

To stop the engine:

1. If locomotive has been loading, allow it to cool down by idling it for at least half an hour. This step is critical to prevent heat-soak restart problems.
2. Set Isolation switch in START/STOP/ISOLATE.
3. Operate an emergency fuel cut-off (EFCO) switch or the Throttle Handle STOP switch, depending on whether you want to shut down only that locomotive's engine or all the engines in the consist.

In addition to the normal engine stop methods above, there is another method associated with the EMDEC system:

On the circuit breaker panel, switch the ENGINE CONTROL circuit breaker Off (lever Down).

**Note:** The EFCO pushbuttons, the throttle handle STOP switch, and the ENGINE CONTROL breaker cut off fuel injection to cause immediate engine shut down. In addition, although it is possible to set the FUEL PUMP switch Off to stop the engine by fuel starvation, this method is not recommended. It should only be used as an emergency stop if there is a problem stopping the engine in the normal manner.

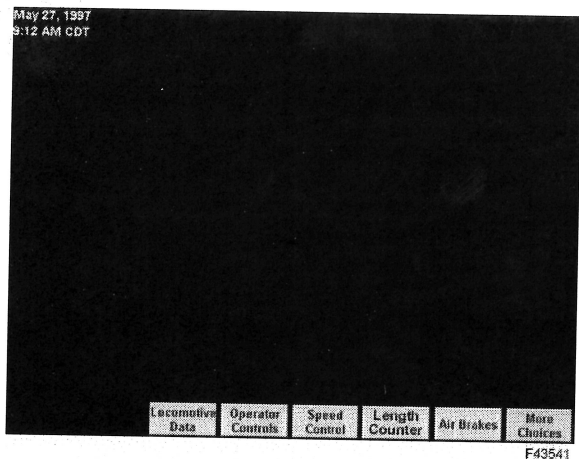
## SPEED CONTROL OPERATION

Locomotive speed control is an EM2000 locomotive computer function. It provides for constant speed operation, as when loading coal at a tipple. A separate pacesetter device is not required.

When operating speed control in power, EM2000 adjusts locomotive power to maintain set speed. Procedure starts below.

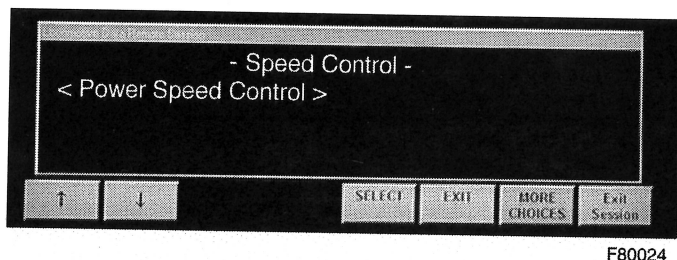
**To operate the locomotive in power speed control:**

1. Set up locomotive for lead operation - reverser thrown (not centered), CONTRL FUEL P. switch On (slider Up), throttle handle set in IDLE, and engine running.
2. Bring up FIRE Main Menu page 1 on the engineer's FIRE panel, Figure 3-15, next.



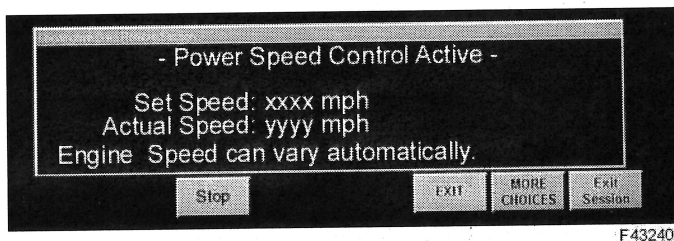
**Figure 3-15. FIRE Main Menu Page 1**

3. Press the *Speed Control* key. Locomotive Data (EM2000) Remote Session window opens, and Speed Control menu displays - Figure 3-16, next.



**Figure 3-16. Speed Control Screen**

4. Use arrow key(s) to pick *Power Speed Control* on the screen.
5. Press the *SELECT* key. *Entry Conditions To Speed Control* screen displays, stating *Reverser handle to direction of travel*.
6. Press *START* key. *Power Speed Control Active* screen displays -



**Figure 3-17. Power Speed Control Active Screen**

If reverser is centered, the *IMPROPER SPEED CONTROL CONDITION* screen appears when the **START** key is pressed.

Throw the reverser to the direction of travel or press the **EXIT** key to end *Speed Control*. When conditions are all correct, the *Power Speed Control Active* screen returns.

7. EM2000 initially sets *Set Speed* equal to *Actual Speed*.
8. Using the *SLOW SPEED CONTROL* keys on the engineer's **FIRE** panel, increase or decrease the displayed *Set Speed* to reach the desired *Set Speed*.  
When *Set Speed* is less than 10 MPH, each tap on the *SLOW SPEED CONTROL* key increases or decreases *Set Speed* by an increment of 0.02 MPH.
9. Advance the throttle to notch 1. EM2000 responds by starting speed control operation, and trainlined units with speed control also start speed control operation.

**Note:** On EMD locomotives, the EM2000 locomotive computer automatically adjusts actual throttle setting (not necessarily the handle setting) as conditions require to maintain *Actual Speed* at *Set Speed*.

Throttle notch 1 may not be sufficient for other locomotives in consist that only respond to the lead locomotive manual throttle setting.

10. Advance the throttle to a setting that is sufficient to fully use the power available from all the units in the consist to maintain set speed.

**Note:** *Power Speed Control* operation does not apply dynamic or air braking to maintain *Set Speed*.

11. To end *Power Speed Control* operation, press the *STOP* key on the *Power Speed Control Active* screen.

## ALERter SYSTEM OPERATION

The alerter system is part of the FIRE system. It monitors various engineer's control console devices for indications that the engineer is present and alert. If it is apparent that the engineer is not present or alert, the alerter system activates a progressive alarm. Then, if not reset during the alarm period, it initiates penalty braking. Alerter is provided with twenty five (25) second warning period with audio and visual warning, audio warning starting at twenty seconds. No alerter cutout is to be provided.

**Any of the following conditions suppress alerter system operation (provided that alerter has not already initiated penalty brake application) .** FIRE does not activate alarm or initiate penalty brake, regardless of engineer's apparent lack of alertness, if:

- Brake cylinder pressure greater than 25 psi, or
- The automatic brake handle in suppression or beyond, or
- Brake pipe pressure is below 20 psi, or
- Air brake system set up for trail cut out service, or
- When all of the following are true:
  - Reverser is centered
  - Isolation Switch Position = Isolate
  - Throttle Position = Idle
  - Speed less than 2.0 MPH
  - Generator Field Switch Position = Open
  - Gen2 FIRE has valid communication with EM2000

**Any of the following activities will cause an alerter timer reset:**

(Alerter system resets its counter to a preset time period)

Alerter system control will be reset from any of the following:

- Throttle changes (Idle, TH 1-8).
- Operation of Engineer's Horn.
- Operation of Engineer's Bell.
- Dynamic Brake changes.
- Movement of the Automatic or Independent Brake handles.
- Application or release of Bail Off.
- Pressing any Gen2 FIRE System Function Display key.
- Safety Control (Alerter) reset switch, provided that alerter system has not detected switch tampering.  
See explanation at end of list.

**ALERter RESET switch tampering protection -**

If ALERter RESET switch operation is too frequent, the alerter system detects tampering and ignores the switch.

However, when too-frequent ALERter RESET switch operation stops, the alerter system automatically reinstates the switch - it again recognizes inputs from the switch.

**Any of the following activities will *NOT* cause an alerter timer reset:**

- Direction changes (Forward, Reverse).
- Operation of Conductor's Horn/Bell.
- Operation of Manual Sanding Function.
- Engineer's Radio Microphone.
- Conductor's Radio Handset.

**Alerter system timing** - When the alerter system is reset by any of the methods described above, the alerter timer is set according to conditions:

- Speed Less than or equal to 3 MPH; Reset Time = 45 Seconds (time to penalty application, includes 20 second reset period plus 25 second warning period).

- Speed greater than 3 MPH; Reset Time is a function of speed with values (time to penalty application, including 25 second warning period) in the range as follows:
  - 176 seconds at 3 MPH
  - 158 seconds at 10 MPH
  - 103 seconds at 40 MPH
  - 83 seconds at 60 MPH

Once the alerter timer is set (and alerter system is not suppressed), it starts counting down. As the countdown progresses, the alerter system activates different alarms to get the attention of the engineer and crew. The following paragraphs detail the sequence.

#### **Alerter system countdown sequence -**

**ALERT 25** The red ALERT indicator to the left displays on the FIRE screen. The count (in seconds) displays under the word ALERT. The indicator starts flashing when the countdown reaches **25 seconds**.

When the alerter countdown reaches **20 seconds**, the ALERT indicator lights continuously, and the FIRE system audio warning device begins sounding. As the count progresses downward, the audio warning grows louder.

When alerter countdown reaches **10 seconds**, the ALERT indicator remains lit continuously and the FIRE system audio warning device sounds at its maximum level. When the alerter countdown reaches **0**, the FIRE system initiates a penalty brake application.

## **DOWNLOADING FIRE GEN 2 EVENT RECORDER**

The FIRE system includes a locomotive event recorder system. The locomotive event recorder collects and records locomotive operation data and events in accordance with FRA requirements and railroad operating rules.

There are two preferred methods for downloading the FIRE event recorder:

- PCMCIA Download - Procedure information starts on page 3-48.
- Laptop Serial Download - Procedure information starts on page 3-49.

**Note:** AIR event recorders can be downloaded during locomotive operation.

## **Event Recorder PCMCIA Download Procedure**

In this procedure, the event recorder sends a copy of its contents to a file on a PCMCIA memory card - either a SRAM card or a flashdisk PC card - that is inserted in the PC card reader located beneath the engineer's workstation.

**Note:** The size of a full event recorder download is typically 1.5 Megabytes. If the inserted memory card - for example, a 512kB SRAM card - has less memory capacity than required for a full download, then only the most recent download data is copied onto the inserted memory card - in this example, the most recent 512kB.

However, if the inserted memory card has sufficient capacity, but not enough free space - for example, if it is a 10MB flashdisk that already has 9MB of Read/Write files - then the 9MB of previous files are erased, from oldest to newest, and replaced with new files as the download progresses. (To protect downloaded event recorder files from such erasing, change them to Read-only files after the download is complete.) If not enough space can be freed up on the inserted memory card to record the whole download, only the most recent data is downloaded until all the free space is filled.

### Download Procedure:

1. Insert the memory card - SRAM card or flashdisk PC card - into the PC reader slot located beneath the engineer's workstation.

The message below appears on the FIRE screen:

**DO NOT REMOVE PC CARD!  
Event Recorder Download is in Progress.**

2. Download usually completes successfully in two to fifteen seconds, and message on screen changes to:

**EVENT RECORDER DOWNLOAD COMPLETE**  
**The PC Card may be removed.**

If something goes wrong during the download, such as write errors caused by problems on the inserted memory card, the following message replaces the **DO NOT REMOVE...** message:

**UNABLE TO UNLOAD EVENT RECORDER TO INSERTED PC CARD**  
**TRY ANOTHER CARD.**

Successful downloads create two files on the inserted memory card - a ".dat" file, containing the event data, and a ".sta" file, containing general tracking information.

## **Event Recorder Laptop Serial Download Procedure**

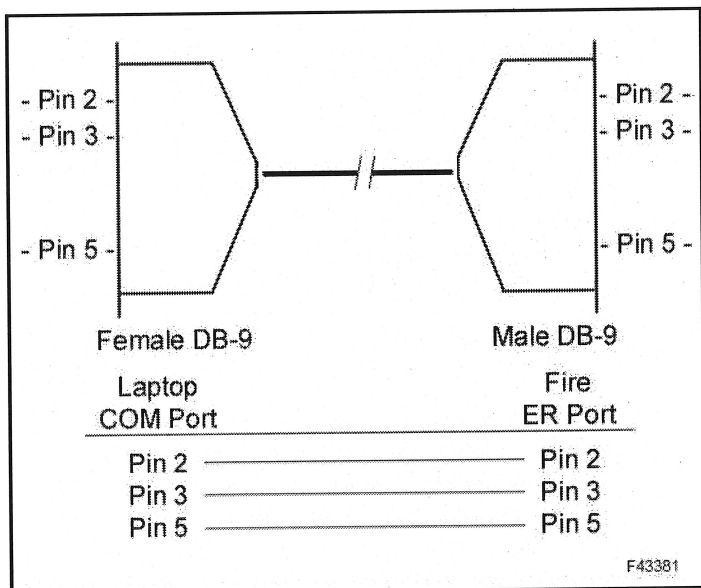
**Note:** The cable that was used for downloading ICE-integrated event recorders cannot be used for downloading FIRE Gen. II integrated event recorders. A new straight-through 9 pin, 6 Ft. long, round shielded cable, Radio Shack catalogue number 26-117, is required for FIRE Gen. II-integrated event recorders. See Figure 3-18, page 3-50, for the new cable configuration.

### **Download Procedure:**

**Note:** If you intend to employ Quantum™ laptop download software, use at least a Revision W version. Older versions may work, but not for sure. Revision K definitely does not work.

1. With the download cable described in the Note above and illustrated in Figure 3-18, connect the laptop **DB9 COM** port to the Event Recorder connector receptacle on the back of the engineer's control stand.





**Figure 3-18. Radio Shack DB9 Download Cable Configuration**

2. Run the download software. The process details may vary depending on which download software you are using, but the basic flow is generally the same:
  - After the download process is started, you may be prompted for a destination directory for the downloaded files, and you may be asked to supply some basic locomotive information, such as -
    - Road Number
    - Download Location
    - Time of Download

Specify a directory as necessary and fill in the requested information.

  - You may be prompted for a percentage of data to be downloaded. Your response will accurately control the download results.
  - You may be prompted for an amount of data to be downloaded based on time. In this case, your reply does not matter - FIRE will download the full data set.

3. Successful downloads create two files - a ".dat" file, containing the event data, and a ".sta" file, containing general tracking information.

## **Event Recorder Playback/Viewer Software**

The same software that is used to view ICE-integrated event recorder downloads from a PCMCIA memory card can be used for FIRE-integrated event recorder downloads. Both Pulse™ and Quantum™ software is known to work.

However, the FIRE system downloads event recorder data to a PCMCIA memory card in a different format than the ICE system does - data downloaded from the FIRE system to a memory card is FAT-formatted.

Therefore, if you are not certain whether the download data you want to view is from an ICE system or a FIRE system, before you load the download data from the memory card into the playback session, enter a "dir" command in DOS on the drive with the memory card. If an error occurs, it is likely that the memory card is not FAT-formatted (not a FIRE event recorder download), and therefore is probably an ICE system download.

Select the "**LOAD FILE FROM DISK**" option(s) from the initial menu(s) for FIRE system downloaded data.



---

---

# Troubleshooting

---

---

## Contents of Section

<u>Heading</u>	<u>Page</u>
INTRODUCTION .....	4-3
AIR BRAKE RESET METHODS .....	4-10



# INTRODUCTION

This section provides some basic SD70M-2 locomotive troubleshooting information. Many troubleshooting procedures can be performed through the FIRE system. Major subsystems such as the EM2000 locomotive computer and electronic air brake are correlated through the FIRE system computer and displayed on the FIRE screen. Locomotive fault and certain operating conditions detected by the EM2000 are displayed automatically on FIRE and can be addressed through the EM2000 on the FIRE system. Access the EM2000 by pressing the *Locomotive Data* key on the FIRE Main Menu. Some typical fault and operating conditions and their recommended responses are provided.

Problems and possible solutions are presented in this order:

<b>PROBLEM: NO ELECTRICAL POWER .....</b>	<b>4-4</b>
<b>PROBLEM: NO FIRE SCREENS .....</b>	<b>4-4</b>
<b>PROBLEM: ENGINE WON'T CRANK OR START .....</b>	<b>4-4</b>
<b>PROBLEM: ENGINE CRANKS, BUT WON'T START .....</b>	<b>4-5</b>
<b>PROBLEM: LOCOMOTIVE WON'T LOAD .....</b>	<b>4-5</b>
<b>PROBLEM: LOCO. WON'T LOAD FULLY .....</b>	<b>4-6</b>
<b>PROBLEM: ENGINE SHUT DOWN .....</b>	<b>4-7</b>
<b>PROBLEM: MISCELLANEOUS FAULT/ OPERATING CONDITIONS .....</b>	<b>4-8</b>
<b>PROBLEM: NO CAB HEATING .....</b>	<b>4-8</b>
<b>PROBLEM: SLIPPED PINION .....</b>	<b>4-9</b>
<b>EMERGENCY OR PENALTY AIR BRAKE WARNING INDICATIONS/ RESET METHODS .....</b>	<b>4-9</b>
<b>AIR BRAKE RESET METHODS .....</b>	<b>4-10</b>
<b>DISABLE OR ENABLE A TRUCK .....</b>	<b>4-12</b>

## Problem: NO ELECTRICAL POWER

Possible Cause	Solution
Battery knife switch open	Close battery knife switch.
No battery power.	Check batteries, cabling, and connections.
Open circuit breakers	Close circuit breakers.

## Problem: NO FIRE SCREEN

Possible Cause	Solution
CAB DISP circuit breaker open.	Close circuit breaker.
Battery knife switch open.	Close battery knife switch.
No battery power.	Check batteries, cabling, and connections.
<b>NOTE:</b> No other locomotive crew-performed procedures are permitted for this system.	

## Problem: ENGINE WON'T CRANK OR START

Possible Cause	Solution
ENGINE CONTROL breaker is open.	Close breaker.
Absent or low air pressure to turn starter motor.	Couple to other locomotive, hook up MR Equalizing line, then pump up main reservoirs.

## Problem: ENGINE CRANKS, BUT WON'T START

Possible Cause	Solution
FUEL INJECTION switch is open.	Set FUEL INJECTION switch in STOP, then in RUN.
Fuel system does not prime.	Close FUEL PUMP breaker.
Insufficient fuel.	Add fuel to tank.
Active EMDEC fault.	Cycle the Engine Control circuit breaker.

## Problem: LOCOMOTIVE WON'T LOAD

Possible Cause	Solution
<b>REVERSER HANDLE IS CENTERED</b> message	Set reverser in Forward or Reverse.
<b>NO LOADING</b> message	
GEN. FIELD switch is Off (Down).	Set switch On (Up).
<b>GROUND RELAY LOCKED OUT</b> message	15 seconds after a ground occurs, EM2000 automatically resets the ground relay. EM2000 will reset GR twice more within a 5 minute period, then lock it out. Once GR locks out, it must be reset through the FIRE system - Locomotive Data function.
<b>Table continues on next page.</b>	



## Problem: LOCOMOTIVE WON'T LOAD

Possible Cause	Solution
<b>NO LOAD - PCS OPEN</b> message, penalty or emergency brake application.	Set throttle in IDLE. Set independent brake in FULL and set automatic brake handle in EMER (emergency), wait 60 seconds, then set automatic brake handle in Release (REL). If air brakes do not recover, cycle AIR BRAKE breaker, then try to recover again.

## Problem: LOCO. WON'T LOAD FULLY

Possible Cause	Solution
<b>REDUCED LOAD-TH6 LIMIT</b> message: Clogged air filters or hot engine.	Try to reset by momentarily reducing throttle handle to IDLE.
<b>REDUCED DYNAMIC BRAKE - GRID OVERCURRENT</b> message.	Reduce dynamic brake handle setting immediately. Reset fault through FIRE system. If fault occurs again, cut out dynamic brake with the DYNAMIC BRAKE switch on the Engine Control Panel.

## Problem: ENGINE SHUT DOWN

Possible Cause	Solution
<b>Note:</b> The EMDEC system computer sends some of the following messages to the EM2000 locomotive computer. They will display on the FIRE system Locomotive Data function.	
ENGINE SHUTDOWN - ENGINE OIL PRESSURE	Check engine oil level. <b>If oil level is too high, <u>do not attempt to restart.</u></b> If oil level is OK, and strong smell of diesel fuel is <u>not</u> present, cycle FUEL INJECTION switch, then attempt to restart. If strong smell of diesel fuel <u>is</u> present, <b><u>do not attempt to restart.</u></b> If engine shuts down again for same problem, do not attempt another restart.
NO LOAD - ENGINE PROTECTION SHUTDOWN	Cycle ENGINE CONTROL breaker, then try restarting engine.
ENGINE SHUTDOWN - ENGINE OIL TEMPERATURE	Cycle ENGINE CONTROL breaker, then try restarting engine.
ENGINE SHUTDOWN - ENGINE CRANKCASE PRESSURE	Do NOT reset until qualified personnel have performed an engine inspection.
ENGINE SHUTDOWN - ENGINE COOLANT PRESSURE	Check coolant level. Cycle ENGINE CONTROL breaker, then try restarting engine.

## **Problem: MISCELLANEOUS FAULT/ OPERATING CONDITIONS**

<b>Possible Cause</b>	<b>Solution</b>
<b>ENGINE SPEED MINIMAL</b> message	Locomotive may be isolated - set Isolation switch in RUN.
No Dynamic Brake	DYNAMIC BRAKE switch on Engine Control Panel may be in CUT OUT. Set it in CUT IN.
Speed Control fault	Reset COMPUTER CONTROL breaker, then run Speed Control Self-Test.

## **Problem: NO CAB HEATING**

<b>Possible Cause</b>	<b>Solution</b>
Cab heater unit fan blows at all speeds and settings, but no heating	Unit has a two hour time-out. Turn it Off and back On to reset. Air filters are plugged - Unit heats for a while, then trips breaker. Check position of cab heater circuit breaker in the electrical locker. Reset if tripped.

### **WARNING**

Operating Personnel are cautioned to **KEEP OUT** of the electrical control locker unless specifically directed by maintenance personnel. High voltage is present within the electrical control locker during, and sometimes after, locomotive operation.

## Problem: SLIPPED PINION

Possible Cause	Solution
Slipped Pinion Suspected	<p>Apply independent air brakes fully.</p> <p>Go to throttle 1 or 2 Stall Test.</p> <p>Check TMRPMs on Creep Control screen.</p> <p>If all except one show zero, then that one pinion is slipping.</p>
<p>Take the following steps to avoid constant wheel slip caused by a slipped pinion:</p> <ol style="list-style-type: none"> <li>Disable the Traction Motor with the defective pinion.</li> <li>Disable the Locked Wheel Detection on the locked wheel detection screen.</li> </ol>	

## EMERGENCY OR PENALTY AIR BRAKE WARNING INDICATIONS/ RESET METHODS

Indication	Reset Method*
Automatic Brake Emergency	Method 1
Emer. Brake Valve Emergency	Method 1
Remote Control Emergency	Method 1
Trainline Emergency	Method 2
EOT Emergency	Method 2
Overspeed Penalty	Method 3
OBC (on-board computer) Penalty (EM2000/FIRE communications loss)	Method 3
Air Brake Power Up Penalty	Method 3

\* See next page for Reset Method descriptions.

# AIR BRAKE RESET METHODS

**Method 1:** Ensure throttle handle is in IDLE position. Set automatic brake handle in EMERGENCY, then wait until the reset message appears or the fault disappears.

**Method 2:** Ensure throttle handle is in IDLE position. Set automatic brake handle in EMERGENCY for 60 seconds, then move it to RELEASE.

**Method 3:** Ensure throttle handle is in IDLE position. Set automatic brake handle in SUPPRESSION and hold for at least eight seconds, then return it to RELEASE.

**Note:** If the above reset strategy is not successful, proceed as follows:

1. Cycle (Off, On) AIR BRAKE breaker on electrical control cabinet upper circuit breaker panel.
2. Set automatic brake handle in SUP (suppression) and hold there for at least eight seconds, then return it to REL (release).

**Note:** Once a penalty brake application is in progress, it cannot be suppressed.

3. If alarm bell cannot be reset or alarm recurs (possible brake system problem), open AIR BRAKE breaker. Electronic air brake system back-up will provide normal trail unit brake operation.

## WARNING: STOPPING HAZARD

Do not, under any circumstances, permit a train to continue in operation if brake pipe air pressure falls below 45 psi. If that does happen, stop the train and recharge the brake pipe to the railroad-specified pressure. Failure to comply with this warning may result in the inability to control or stop the train.

### **WARNING: STOPPING HAZARD**

If electronic air brake system suffers 24 Volt power loss and locomotive battery power loss while train is moving, a penalty brake application occurs at the SERVICE rate (BP pressure drops to zero). Crew may initiate an EMERGENCY brake application from the engineer's automatic brake handle, or from the EMERGENCY BRAKE VALVE on the conductor's console.

### **WARNING: STOPPING HAZARD**

After an EMERGENCY BRAKE application, if the train is still moving, do not attempt to release brakes. Setting the automatic brake handle in REL while the train is moving may cause equipment damage and/or personnel damage.

**Note:** If electronic air brake system operating power is lost, the following occurs:

1. Alarm bell sounds. It can be silenced locally.
2. PCS opens, interrupting locomotive power.  
Dynamic brake operation is affected per Railroad Procedures.
3. A penalty brake application occurs and brake cylinder pressure rises to 78-80 psi, maximum.
4. Independent brake control does not operate, including the bail-off function.
5. The operator may reset the failure by cycling (Off, On) the AIR BRAKE breaker on the electrical control cabinet upper circuit breaker panel.

**Note:** If locomotive is trailing in consist when electronic air brake system operating power is lost, also note the following:

1. Bail-off is still permitted, with reapplication limited to further reductions in brake pipe pressure.
2. There will be no change in air brake, power, or dynamic brake conditions.
3. Independent Brake will apply and release when commanded by the LEAD unit limited to A&R pipe pressure.

# Index

In this index:

- **Circuit breakers** are not listed separately - each is only listed once, under the **Breakers** - heading.  
Example - There is no AC Control Circuit Breaker entry, but AC Control is listed under **Breakers**.
- **Indicators**, in the same manner, are listed only once, under the **Indicators** - heading.
- **Switches**, in the same manner, are listed only once, under the **Switches** - heading.

## A

ACCELERATING THE TRAIN 3-24  
 AIR BRAKE CONTROLLER .... 2-32  
 AIR BRAKE EQUIPMENT ..... 2-31  
 AIR BRAKE RESET  
   METHODS ..... 4-10  
 AIR BRAKE SET UP ..... 3-6  
 AIR BRAKE SYSTEM ..... 1-4  
 AIR BRAKE SYSTEM,  
 ELECTRONIC,  
 INTRODUCTION ..... 1-18  
 AIR BRAKE WARNINGS/  
 RESETS ..... 4-9  
 AIR BRAKES FUNCTIONS ON  
 FIRE SYSTEM ..... 2-29  
 AIR COMPRESSOR ..... 1-4  
 AIR PRESSURE, MAIN  
 RESERVOIR ..... 2-56  
 AIR, PUMPING UP ..... 3-14  
 ALARM BELL SILENCE ..... 2-21  
 ALARM HORN, ENGINE  
 START ..... 2-55  
 ALARM INDICATOR ..... 2-15  
 ALERT INDICATOR ..... 2-15, 3-47  
 ALERTER DEPARTURE  
 TEST ..... 3-21  
 ALERTER SYSTEM  
 OPERATION ..... 3-45  
 AUTO. BRAKE HANDLE ..... 2-33

## B

BATTERIES, LOCOMOTIVE .... 1-4

BRAKE SET UP, AIR ..... 3-6

## BREAKERS -

AIR BRAKE ..... 2-53  
 AUX. GEN. F.B. .... 2-51  
 CAB/ DISP (FIRE) ..... 2-53  
 COMPUTER  
   CONTROL ..... 2-51, 2-53  
   CONTROL ..... 2-52  
 EM2000 ..... 2-53  
 EMDEC ..... 2-52  
 ENGINE CONTROL ..... 2-52  
 FUEL GAUGE ..... 2-51  
 HDLTS (HEADLIGHTS) ..... 2-52  
 HEATED WINDOWS ..... 2-51  
 LIGHTS ..... 2-52  
 LOCAL CONTROL ..... 2-52  
 LOCOMOTIVE COMPUTER 2-53  
 RADIO ..... 2-51

## C

CA9 ..... 1-6  
 CAB EQUIPMENT ..... 2-3  
 CHANGE (TRAIN) LENGTH ... 2-22  
 CHANGE PROFILE KEY ..... 2-21  
 CIRCUIT BREAKER - SEE  
 BREAKERS -  
 CIRCUIT BREAKER PANEL ... 2-50  
 CIRCUIT BREAKER PANEL ... 2-50  
 COMPANION ALTERNATOR ... 1-6  
 COMPARTMENT, SHORT  
 HOOD INNER ..... 2-54  
 COMPRESSOR ..... 1-4



COMPUTER, LOCOMOTIVE . For-ii	
CONDUCTOR'S CONSOLE ...	2-43
CONSOLE, LOWER .....	2-5
CONTROLLED CREEP .....	3-25
CONTROLLER, AIR BRAKE ...	2-32
CONTROLLER, LOCOMOTIVE ..	2-35, .....
	2-40
CONTROLS AND INDICATORS .....	2-1
COUNTDOWN (TRAIN) LENGTH .....	2-24
COUPLING LOCOMOTIVE TO TRAIN .....	3-14
COUPLING LOCOMOTIVES TOGETHER .....	3-13
CREEP CONTROL .....	3-25
CREW MEMBER TERMS IN THIS MANUAL .....	For-iii
CURVE NEGOTIATION, MIN. ..	1-5
CUTOUT COCK, DEAD ENG. .	2-34
<b>D</b>	
DEAD ENG. CUTOUT COCK .	2-34
DEAD LOCOMOTIVE .....	3-40
DEPARTURE TESTS -	
ALERTER (RESET) .....	3-21
GENERAL .....	3-14
OVERSPEED .....	3-19
PENALTY BRAKE .....	3-16
DIESEL ENGINE CONTROL SYSTEM .....	1-12
DIESEL ENGINE CONTROLLER .....	1-14
DIMENSIONS, LOCOMOTIVE, NOMINAL .....	1-5
DIMMER, READING LIGHT .....	2-4
DIPSTICK, ENGINE OIL .....	3-4
DISPLAY PANELS, FIRE .....	2-10
DISPLAY SETUP, FIRE .....	2-21
DOUBLE HEADING .....	3-32
DOWNLOADING EVENT RECORDER .....	3-47
DTMF KEYPAD, RADIO .....	2-43
DYN BRAKE INDICATOR .....	2-15, 3-47
DYNAMIC BRAKE -	
DESCRIPTION .....	3-33
LOCOMOTIVES IN CONSIST .....	3-36
OPERATION, GENERAL .....	1-13

PROCEDURE .....	3-33
<b>E</b>	
EFECO/STOP SWITCH .....	2-47
ELECTRICAL CONTROL CABINET .....	2-44
ELECTRONIC AIR BRAKE SYS. ....	1-18
EM INDICATOR .....	2-18
EM2000 .....	For-ii, 1-7, 1-13
EM2000 ON FIRE SYSTEM ....	2-26
EMDEC .....	1-12, 1-14
EMDEC SYSTEM INTRODUCTION .....	1-17
EMERGENCY BRAKE APPL. BY EOTD. ....	2-16
EMERGENCY BRAKE VALVE .	2-43
EMERGENCY BRAKE, END-OF-TRAIN .....	2-41
EMERGENCY BRAKING .....	2-33
EMERGENCY FUEL CUTOFF/STOP SWITCH .....	2-47
EMERGENCY STOPPING .....	3-24
END-OF-TRAIN EMERGENCY BRAKING .....	2-41
ENGINE -	
CONTROL BREAKER .....	2-52
CONTROL SYSTEM .....	1-12
CONTROLLER .....	1-14
DIPSTICK, OIL .....	3-4
INSPECTION .....	3-4
OVERSPEED .....	2-56
SPEED .....	1-17
ENGINE CRANKS, BUT WON'T START .....	4-5
ENGINE SHUTDOWN, UNEXPECTED .....	4-7
ENGINE START -	
ALARM HORN .....	2-55
LEAD LOCO. PROCEDURE ..	3-9
SETUP .....	3-8
SWITCH .....	2-48
SYSTEM .....	3-7
ENGINEER'S CONSOLE .....	2-5
ENGINEER'S RT. FIRE PANEL .....	2-11
ENGINE ROOM EQUIPMENT .	2-55
ENGINE ROOM INSPECTION ..	3-3
EOT -	
ARM/DISARM .....	2-30

BATTERY DEAD INDICATOR .....	2-16	EOT MOVE INDICATOR .....	2-16
BATTERY LOW INDICATOR .....	2-16	FC 1 DISPLAY PANEL .....	2-11
COMM TEST .....	2-30	FR NO COMM INDICATOR ..	2-16
CONDITIONS .....	2-16	FUEL MONITOR, REMOTE ..	2-31
EMERGENCY BRAKE APPL. ....	2-16	HORN ICON .....	2-18
ID ON FIRE SYS. ....	2-30	HOTD COMM INDICATOR ..	2-16
LAST CAR INDICATORS ....	2-18	ICON INDICATORS .....	2-18
MOVE INDICATOR .....	2-16	IDENT INDICATOR .....	2-18
REAR EMERG BRAKE SWITCH .....	2-41	INTRODUCTION TO SYSTEM .....	1-14
EVENT RECORDER DOWNLOAD .....	3-47	INVLD DATA INDICATOR ...	2-16
EVENT RECORDER PLAYBACK & VIEW SOFTWARE .....	3-51	LAST CAR INDICATORS ....	2-18
<b>F</b>		LENGTH COUNTER MENU ..	2-22
FIRE -		LOCO. MONITOR FUNCTION .....	2-31
AB FAIL INDICATOR .....	2-15	LOCOMOTIVE DATA (EM2000) .....	2-26
ACCEL INDICATOR .....	2-13	LOW EOT BATT INDICATOR .....	2-16
AIR BRAKE SETUP INDICATOR ..	2-17	MAIN MENU, ENG. RT. PG. 1 .....	2-19
AIR BRAKES FUNCTIONS ..	2-29	MAIN MENU, ENG. RT. PG.2 .....	2-20
ALARM BELL SILENCE .....	2-21	MAINT. MODE .....	2-26
ALERT INDICATOR ....	2-15, 3-47	MARKER (EOT) INDICATOR .....	2-18
BELL ICON .....	2-19	MEASURED MILE FUNCTION .....	2-25
CHANGE LENGTH FUNCTIONS .....	2-22	ODOMETER .....	2-12
CHANGE PROFILE KEY ....	2-21	OPERATOR CONTROLS MENU .....	2-20
CLIMATE CONTROL .....	2-18	PCS OPEN INDICATOR ....	2-14
COUNTDOWN LENGTH FUNCTION .....	2-24	REAR (EOT BP PRESS.) INDICATOR .....	2-12
DEAD EOT BATT INDICATOR .....	2-16	REAR EMER INDICATOR ...	2-16
DEFOGGER .....	2-18	REAR EMER INDICATOR ...	2-16
DISPLAY PANELS, ENGINEER .....	2-10	REVERSER INDICATOR ....	2-14
DISPLAY PANELS, GENERAL .....	1-13	RF NO COMM INDICATOR ..	2-16
DISPLAY SETUP .....	2-21	ROAD NUMBER INDICATOR .....	2-12
DISTANCE INDICATOR ....	2-14	SAND ICON .....	2-19
DYN BRAKE INDICATOR .....	2-15, 3-47	SET SPEED INDICATOR ....	2-17
EM INDICATOR .....	2-18	SPEED CHECK .....	2-25
ENGINEER'S RT. DISP. PANEL .....	2-11	SPEED CONTROL FUNCTION .....	2-29
EOT COMM. FAULTY .....	2-16	SPEED CONTROL INDICATOR .....	2-17
EOT ID .....	2-30	SPEED CONTROL INDICATOR .....	2-17

THROTTLE INDICATOR .....	2-14
TRACTIVE EFFORT INDICATOR .....	2-14
TRAIN LENGTH INDICATOR .....	2-14
UNIT ALARM INDICATOR ..	2-15
VALVE FAIL .....	2-16
WHEEL SLIP INDICATOR ...	2-14
FIRE EXTINGUISHERS .....	2-57
FR NO COMM INDICATOR ....	2-16
FRONT INSTRUMENT PANEL, CONSOLE .....	2-10
FUEL FILTER PRESSURE .....	2-56
FUEL LEAKS .....	3-4
FUEL MONITOR, REMOTE ....	2-31
FUEL PRIMING, ENGINE .....	1-12

## G

GENERAL ARRANGEMENT, LOCOMOTIVE .....	1-8
GENERAL INFORMATION ..	TOC-i,

## H

HANDBRAKE .....	2-57
HANDLE, AUTO. BRAKE .....	2-33
HANDLE, IND. BRAKE .....	2-34
HANDLING LIGHT LOCOMOTIVE .....	3-13
HANDSET, RADIO .....	2-43
HAULING LOCO. DEAD IN TRAIN .....	2-34
HEATERS, BATTERY .....	1-4
HELPER SERVICE OPERATION .....	3-32
HORN, ALARM, ENGINE START .....	2-55
HOTD COMM INDICATOR .....	2-16

## I

IDENT INDICATOR .....	2-18
IND. BRAKE HANDLE .....	2-34
INDICATIONS, WHEEL SLIP ..	3-25
INDICATORS -	
AIR BRAKE FAIL .....	2-15
AIR BRAKE SETUP INDICATOR .....	2-17
BELL .....	2-19
EOT MARKER .....	2-18
FIRE ICONS .....	2-18
HORN .....	2-18
SAND .....	2-19
SET SPEED .....	2-17

SPEED CONTROL .....	2-17
WHEEL SLIP .....	3-25
WINDSHIELD DEFOGGER ..	2-18
INSPECTIONS -	

CAB, LEAD .....	3-5
CAB, TRAIL .....	3-10
ENGINE .....	3-4
ENGINEROOM .....	3-3
GROUND .....	3-3
INVLD DATA INDICATOR .....	2-16
ISOLATING LOCOMOTIVE ....	3-36
ISOLATION SWITCH .....	2-46

## K

KEYPAD, DTMF, RADIO .....	2-43
---------------------------	------

## L

LEAKS -	
FUEL .....	3-4
LEAVING LOCOMOTIVE UNATTENDED .....	3-41
LENGTH COUNTER, FIRE .....	2-22
LIGHT LOCOMOTIVE HANDLING .....	3-13
LOAD REGULATION .....	1-14
LOCKED WHEEL -	
CONDITION .....	3-26
DETECTION ENABLE/DISABLE .....	3-28
LOCO. MONITOR, FIRE .....	2-31
LOCOMOTIVE -	
BATTERIES .....	1-4
COMPUTER (EM2000) .....	For-ii
COMPUTER CONTROL BREAKER .....	2-53
CURVE NEGOTIATION .....	1-5
DEAD-IN-TRAIN .....	2-34
DIMENSIONS .....	1-5
GENERAL ARRANGEMENT ..	1-8
GENERAL DESCRIPTION .....	1-6-1-11
OPERATION, GENERAL .....	1-11-1-17
POWER DISTRIBUTION .....	1-6
SPEED LIMIT .....	3-30
WEIGHT .....	1-5
WON'T LOAD .....	4-5
WON'T LOAD FULLY .....	4-6
LOCOMOTIVE COMPUTER ....	1-7
LOCOMOTIVE COMPUTER ON FIRE SYS. ....	2-26

LOCOMOTIVE	
CONTROLLER .....	2-35, 2-40
LUBE OIL PRESSURE .....	2-55
LUBE OIL TEMPERATURE ....	2-55
<b>M</b>	
MAIN MENU, EM2000 LOCO.	
COMPUTER .....	2-26
MAIN MENU, FIRE .....	2-19, 2-20
MAINTENANCE MODE, FIRE	2-26
MANUAL SHUTTER	
CONTROL .....	2-56
MEASURED MILE	
FUNCTION, FIRE .....	2-25
MECH. INTERLOCKS ON LOCO.	
CONTROLLER .....	2-38
MISC. EQUIPMENT .....	2-57
<b>N</b>	
NO ELECTRICAL POWER .....	4-4
NO FIRE SCREENS .....	4-4
NO HEAT IN CAB .....	4-8
<b>O</b>	
ODOMETER .....	2-12
ON LINE, LOCOMOTIVES .....	3-12
OPERATOR CONTROLS	
MENU .....	2-20
OVERHEAD CONSOLE .....	2-3
OVERSPEED DEPARTURE	
TEST .....	3-19
OVERSPEED, ENGINE .....	2-56
<b>P</b>	
PANELS -	
CIRCUIT BREAKER .....	2-50
FIRE DISPLAY .....	2-10
FRONT INSTRUMENT .....	2-10
SWITCH .....	2-6
PCS OPEN INDICATOR .....	2-14
PENALTY BRAKE	
DEPARTURE TEST .....	3-16
PLUGGING MOTORS .....	3-24
POWER DISTRIBUTION,	
LOCOMOTIVE .....	1-6
PRECAUTIONS BEFORE	
OPERATING LOCO. ....	3-12
PREPARATION FOR SERVICE	3-3
PRESSURE, LUBE OIL .....	2-55
PUMPING UP AIR .....	3-14

## R

RADIATOR SHUTTER	
CONTROL .....	2-56
RADIO TRANSCEIVER .....	2-40
READING LIGHT .....	2-4
REAR (EOT BP PRESS.) .....	2-12
REAR EMER INDICATOR .....	2-16
REAR EMER. BR. VLV. FAIL	
INDICATOR .....	2-16
REVERSER, EMERGENCY	
USE .....	3-24
RF NO COMM INDICATOR ....	2-16
RUN .....	2-46

## S

SET UP AIR BRAKE .....	3-6
SETTING LOCOMOTIVES	
ON LINE .....	3-12
SETUP, ENGINE START .....	3-8
SHORT HOOD INNER	
COMPARTMENT .....	2-54
SHUTTER CONTROL VALVE	2-56
SLIPPED PINION .....	4-9
SLOW SPEED CONTROL	
OPERATION .....	3-42
SPEED CHECK,	
LOCOMOTIVE .....	2-25
SPEED CONTROL FUNCTION	
ON FIRE SYSTEM .....	2-29
SPEED CONTROL	
OPERATION .....	3-42
SPEED LIMIT .....	3-30
START SYSTEM, ENGINE .....	3-7
START/ STOP/ ISOLATE .....	2-46
STARTING PROCEDURE,	
ENGINE .....	3-9
STARTING TRAILING	
LOCOS. ....	3-12
STOPPING ENGINES .....	3-42
SWITCH PANEL,	
ENGINEER'S CONSOLE .....	2-6
SWITCHES -	
ALERTER RESET, 1 & 2 ....	2-41
ATTENDANT CALL .....	2-41
AUX CAB HTR ENGR .....	2-49
AUX LTS - FRONT .....	2-6
BELL .....	2-41
CONSOLE SWITCH PANEL ..	2-6
CONTROL/ FUEL P. ....	2-8

DYNAMIC BRAKE (CUTOUT) .....	2-46
EFCO, EXTERNAL .....	2-57
EFCO/ STOP .....	2-47
EMERG. FUEL C/O ....	2-47, 2-57
ENGINE RUN .....	2-8
ENGINE START .....	2-48
EOT REAR EMERG BRAKE .....	2-41
FRESH AIR MAKE UP BLOWER .....	2-49
GEN. FIELD .....	2-8
GROUND RELAY CUTOUT	2-51
HDLTS-FRONT .....	2-6
HDLTS-REAR .....	2-7, 2-8
HEADLIGHT CONTROL .....	2-45
HORN .....	2-40, 2-42
ISOLATION .....	2-46
READING LIGHT .....	2-4
SLIDE .....	2-48
START .....	2-48
STEP LIGHTS .....	2-9

## T

TEMPERATURE, ENGINE COOLANT .....	2-55
TEMPERATURE, LUBE OIL ...	2-55
THROTTLE SETTING .....	1-14
TOWING LOCOMOTIVE DEAD IN CONSIST .....	3-40
TOWING LOCOMOTIVE DEAD IN TRAIN .....	3-39
TRACTION MOTOR PLUGGING .....	3-24
TROUBLESHOOTING LOCO. WON'T LOAD .....	4-6, 4-7, 4-8, 4-9
TROUBLESHOOTING - AIR BRAKE WARNINGS/RESETS .....	4-9
ENGINE CRANKS, WON'T START .....	4-5
ENGINE SHUT DOWN .....	4-7
ENGINE WON'T CRANK .....	4-4
ENGINE WON'T START .....	4-4
INTRODUCTION .....	4-3
LOCO. WON'T LOAD .....	4-5
LOCO. WON'T LOAD FULLY	4-6
MISC. FAULT/ OP. CONDS. .	4-8
NO CAB HEAT .....	4-8

NO ELECT. POWER .....	4-4
NO FIRE SCREENS .....	4-4
SLIPPED TM PINION .....	4-9

## U

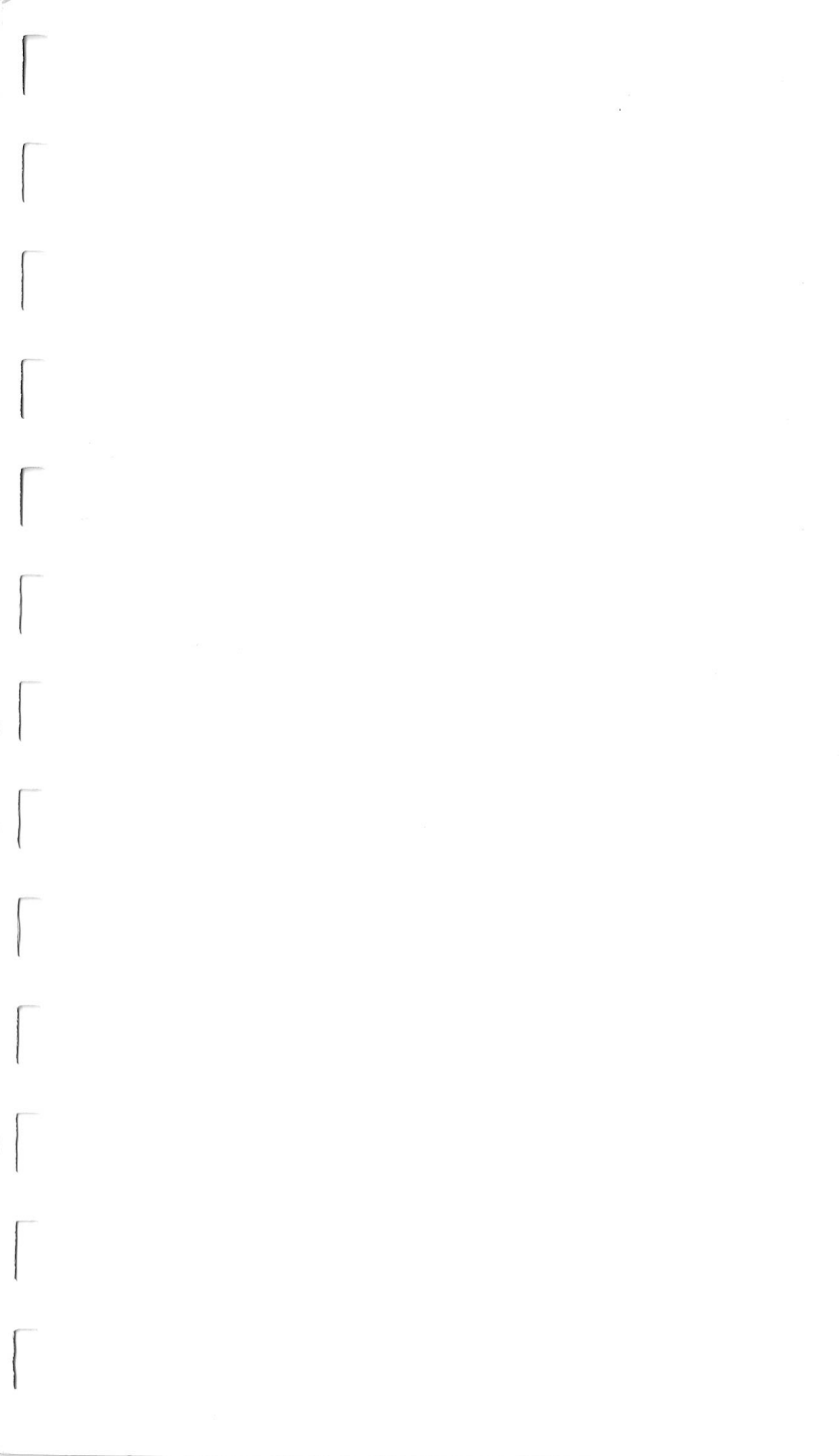
UNIT ALARM INDICATOR .....	2-15
UPPER CONSOLE .....	2-3

## V

VESTIBULE, SHORT HOOD INNER .....	2-54
VOICE RADIO .....	2-40

## W

WATER TEMPERATURE PROBES .....	2-55
WEIGHT, LOCOMOTIVE .....	1-5
WHEEL CONTROL .....	3-25
WHEEL CREEP CONTROL ....	3-25
WHEEL SLIP CONTROL .....	3-25
WHEEL SLIP INDICATOR .....	2-14
WORK STATION, CONDUCTOR'S .....	2-43





**ELECTRO-MOTIVE**

**SD70M-2**

**LOCOMOTIVE**

**CANADIAN NATIONAL  
RAILWAYS**